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THEATER-LEVEL GROUND COMBAT ANALYSES AND THE TACWAR SUBMODELS

Robert J. Atwell, *Project Leader*
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July 1991

Prepared for
Joint Chiefs of Staff

IDA

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This document is a collection of information related to theater analyses with emphasis on the Tactical Warfare Model (TACWAR) ground and theater control submodels. The intended reader is a theater-level combat analyst such as a newly assigned Joint Staff officer. This briefing is intened to provide some general information regarding theater-level combat analyses and as such, does not restrict itself strictly to the TACWAR model.

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PREFACE

This document was prepared under IDA contract MDA 908 89 C 0003, in partial fulfillment of Task Order T-I6-682, Net Assessment Methodologies and Critical Data Elements for Strategic and Theater Force Comparisons. It was sponsored by the Conventional Forces Assessment Division (CFAD) of the Force, Structure, Resource, and Assessment Directorate (J-8) of the Joint Chiefs of Staff.

This document is a collection of information related to theater analyses with emphasis on the Tactical Warfare Model (TACWAR) ground and theater control submodules. The intended reader is a theater-level combat analyst such as a newly assigned Joint Staff officer. This briefing is intended to provide some general information regarding theater-level combat analyses and, as such, does not restrict itself strictly to the TACWAR model.

The author wishes to thank project leader, Dr. Robert J. Atwell, Dr. Leo Schmidt, and Dr. Alan Rolfe of IDA, and personnel in CFAD and JDSSC for their thorough and helpful reviews of this document.

The purpose of this briefing booklet is to provide an overview of theater analyses with emphasis on the Tactical Warfare Model (TACWAR) ground and theater control submodules.

The intended reader is a theater-level combat analyst such as a newly assigned Joint Staff officer. This briefing is intended to provide some general information regarding theater-level combat analyses and, as such, does not restrict itself strictly to the TACWAR model.

Some desirable theater-level features are not currently represented in TACWAR (e.g., C3I, maneuver). Other missing features in the model will become obvious to a new user as they begin to use the model for analyses and studies. Some of the missing features, for instance, medical representation would not be difficult to incorporate into the TACWAR model from a technology standpoint.

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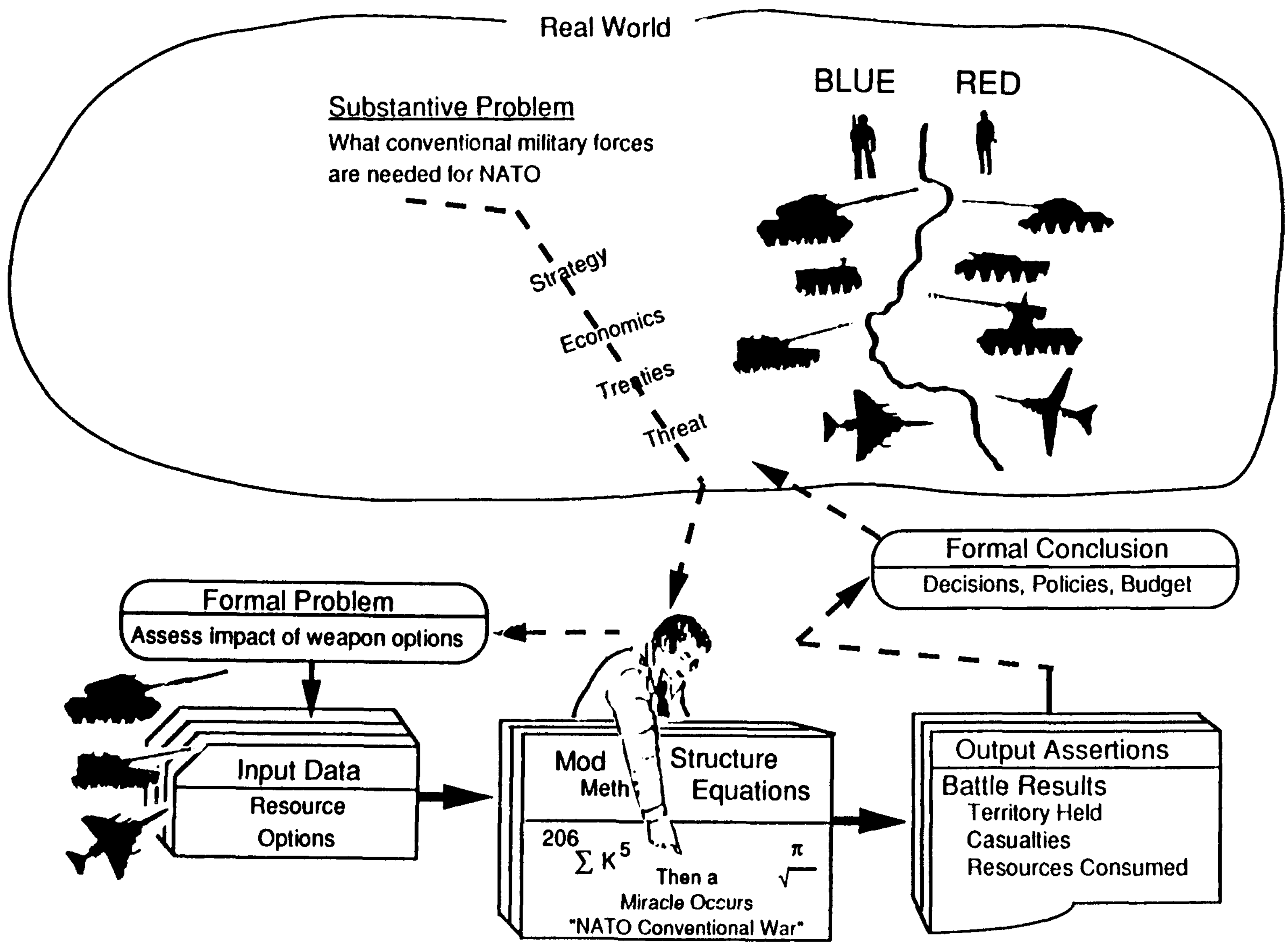
TACWAR GROUND AND THEATER - BRIEFING

- Purpose
  - -- Understanding the conceptual underpinning of both the TACWAR ground combat submodel and TACWAR theater control
  - -- Provide a basis for understanding the modeling of theater-level operations and force composition
- Features of Model
  - -- The TACWAR ground combat entails detailed, well-defined representations of
    - * Force compositions
    - * Geographical settings
    - * Weapons performance
    - * Military tactics and strategies
- Outputs of Model
  - -- Credible insights of theater-level warfare
    - With due caution, general or rough indications of likely battle outcomes under given scenarios
  - -- Trends
    - Indications of directions and relative improvements
- Useful for
  - -- Helping to establish and justify concepts
  - -- Indicating need for field testing
  - -- Understanding effects of combinations of old and new weapons
  - -- Understanding scenarios for conventional, nuclear, and chemical warfare

This briefing booklet offers introductory information about using a model to help with analysis of some theater-level problems. The emphasis of this document is the ground submodel and theater control subsections of the Tactical Warfare Model (TACWAR). The air, supply, chemical, and nuclear submodel information is covered in other briefing booklets.

A new Joint Staff officer will soon become accustomed to the varied terminology commonly used by modeling analysts. There are few hard rules followed in the community regarding the use of words such as: model, simulation, wargame, submodel, routine, function, subroutine, etc.

ANALYSIS OF THEATER PROBLEMS



Source: GAO-PAD-80-21

These are a few major elements of theater-level tactical analyses that a TACWAR model might address. TACWAR-supported analyses are comparative in nature. That is, a baseline run of the model is established and subsequent analysis results (in terms of the elements listed and others) are evaluated relative to the baseline model run. The analyses indicate relative trends and degrees of change from the baseline run.

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MAJOR ELEMENTS OF THEATER ANALYSES

Objective:	**What we desire to achieve**
Alternatives:	**Competitive means for achieving the goal**
Costs:	**Resource expenditures to acquire each alternative**
Effectiveness Scale:	**Scale indicating degree of achievement of goal**
Effectiveness:	**Position on effectiveness scale assigned to each alternative (by measurement)**
Criterion:	**Statement about cost and effectiveness which determines choice**

Some of the operational considerations of a theater-level analysis

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THEATER-LEVEL ANALYSES OPERATIONAL CONSIDERATIONS

- Battle Management
  - Decision processes, orders, reasons
  - Intelligence reports, sources
  - Communication delays
  - Fire orders, response times, accuracies
- Tactical Doctrine
  - Sub-unit location, density, movement rate
  - Target detection, actions
- Weapons Employment
  - Fire-target locations
  - Hit/kill probabilities

TACWAR is a computerized deterministic representation of tactical warfare at the theater level.

TACWAR can be used to evaluate a simplified concept of theater-level combat involving men, equipment, operating procedures and combat support. Other considerations are included as realism is added to a basic model.

A CONCEPT OF COMBAT

RED

- Men
- Equipment
- Operating Procedures (Tactics/Doctrine)
- Combat Support

BLUE

- Men
- Equipment
- Operating Procedures (Tactics/Doctrine)
- Combat Support

OPERATIONAL ENVIRONMENT
(Climate Conditions, Terrain, etc.)

COMBAT OPERATIONS OUTCOME

ConceptCombat

Some additional items that should be portrayed in a ground submodel of theater-level combat operations include the items listed. TACWAR considers many of these in varying degrees of realism. Some items are still under consideration for inclusion.

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COMBAT OPERATIONS

COMMAND AND CONTROL

- Mission
- Composition of force
- Supporting units (artillery, aviation)
- Battle plan
- Time of Battle
- Posture (e.g., hasty defense)

LOGISTICS

- Resupply
- Transportation
- Medical
- Equipment repair
- Construction (roads, bridges, etc.)

ATTRITION (COMBAT LOSSES)

- Weapon/target characteristics (air-to-air, air-to-ground, composition of force, ground-to-air, ground-to-ground)
- Munition characteristics (e.g., precision-guided or free-flight, fragmenting or solid shot)
- Engagement characteristics (visibility, movement, range, terrain, etc.)

A few examples of some theater-level Measures of Effectiveness (MOEs)

EXAMPLES OF THEATER-LEVEL MEASURES OF EFFECTIVENESS

MOVEMENT OF FORWARD EDGE OF BATTLE AREA (FEBA)

- Territory controlled

LOSSES

- Personnel
- Weapons (destroyed and damaged)

RESOURCE CONSUMPTION

- Ammo expended
- Fuel Used
- Supplies consumed
- Equipment lost

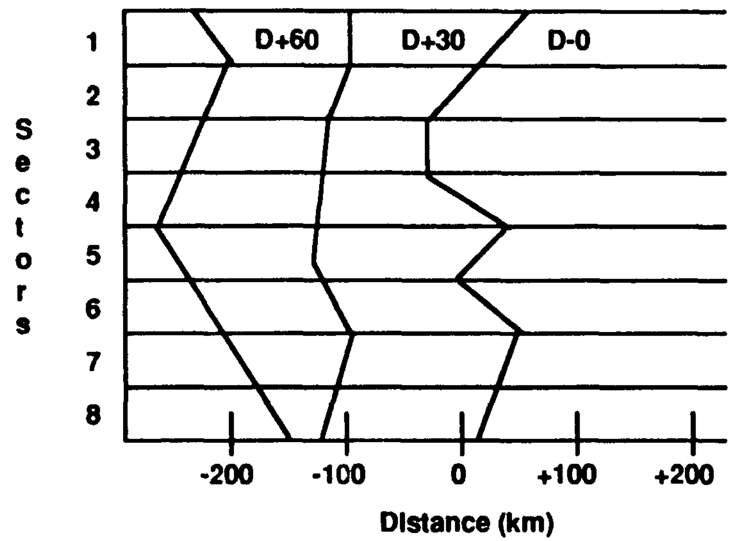
RESOURCES REMAINING

Sample measures of effectiveness include:

- **FLOT/FEBA movement**
- **Kill ratios**
- **Killer-victim scoreboards**

SAMPLE MEASURES OF EFFECTIVENESS

FEBA MOVEMENT



KILL RATIOS

$\frac{\text{Red weapons killed}}{\text{Blue tanks killed}}$ $\frac{\text{Red tanks killed}}{\text{Blue tanks killed}}$

$\frac{\text{Blue tanks killed}}{\text{Red ATGM killed}}$ $\frac{\text{Blue personnel killed}}{\text{Red small arms killed}}$

KILLER - VICTIM SCOREBOARD
Red Victim

Blue Killers	T54	T62	BRDM	BMP	ATGM	Small Arms
M60						
ABRAMS						
M113						
TOW						
DRAGON						
Small Arms						

OTHER MOEs

Sortie generation = $\frac{\text{Total sorties}}{\text{Days of combat}}$

Air-to-air losses = Number of aircraft lost in air-to-air combat

Aircraft presence = Number of aircraft in Theater at given times

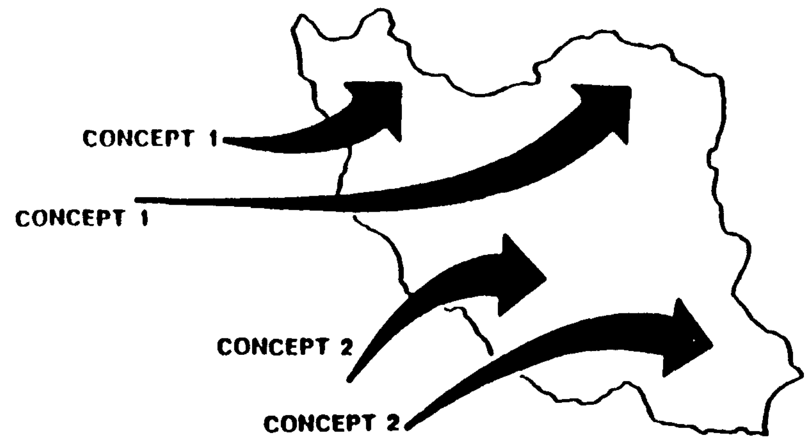
CAS effectiveness = Number of ground weapons killed by air

Some applications of theater combat analyses

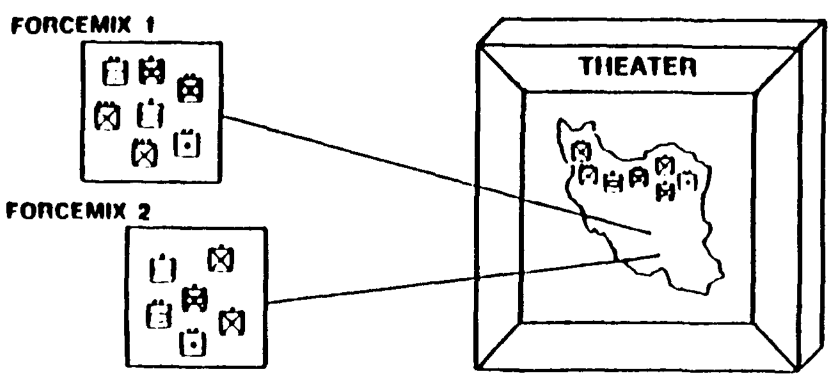
APPLICATIONS OF THEATER COMBAT ANALYSES

DEPLOYMENT PLANNING

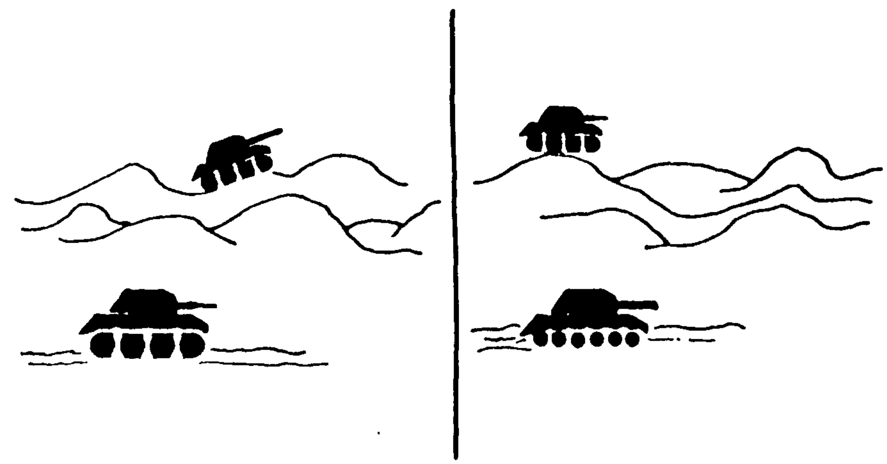
ALTERNATIVE CONCEPTS OF EMPLOYMENT



ALTERNATIVE FORCES AND MIXES



ALTERNATIVE WEAPON SYSTEMS

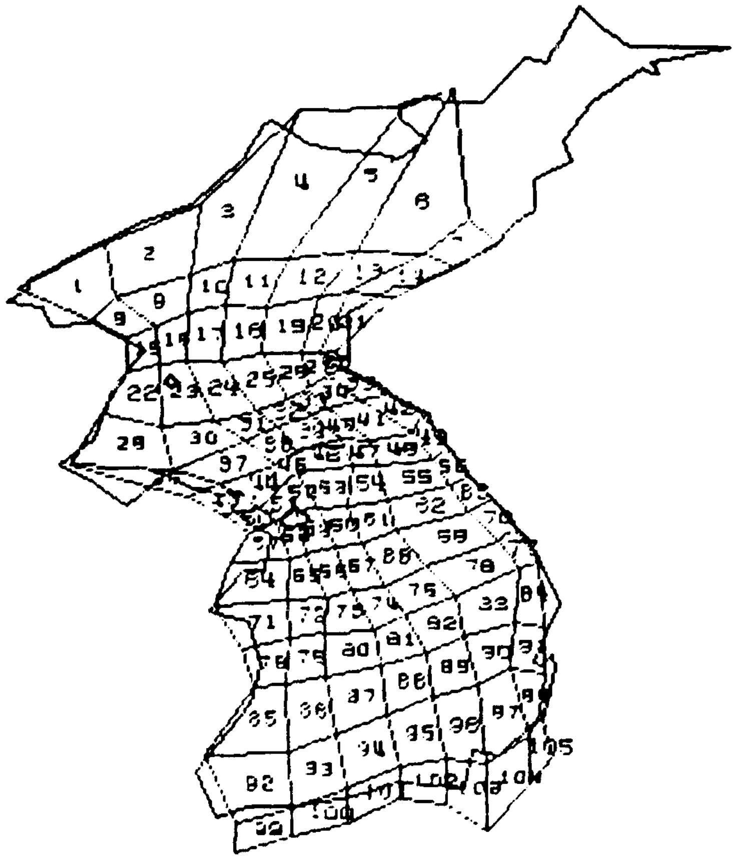


Source: GAO-PAD-80-21

ApplTheaterCmbtAnal

Illustrative examples used in this briefing booklet were mainly developed with central European and Korea warfare in mind. After a short discussion of consideration for modeling ground combat, in general, the emphasis will shift to using TACWAR as a tactical warfare modeling tool.

THEATER BATTLE AREA NUMBERS FOR A KOREA ILLUSTRATIVE EXAMPLE



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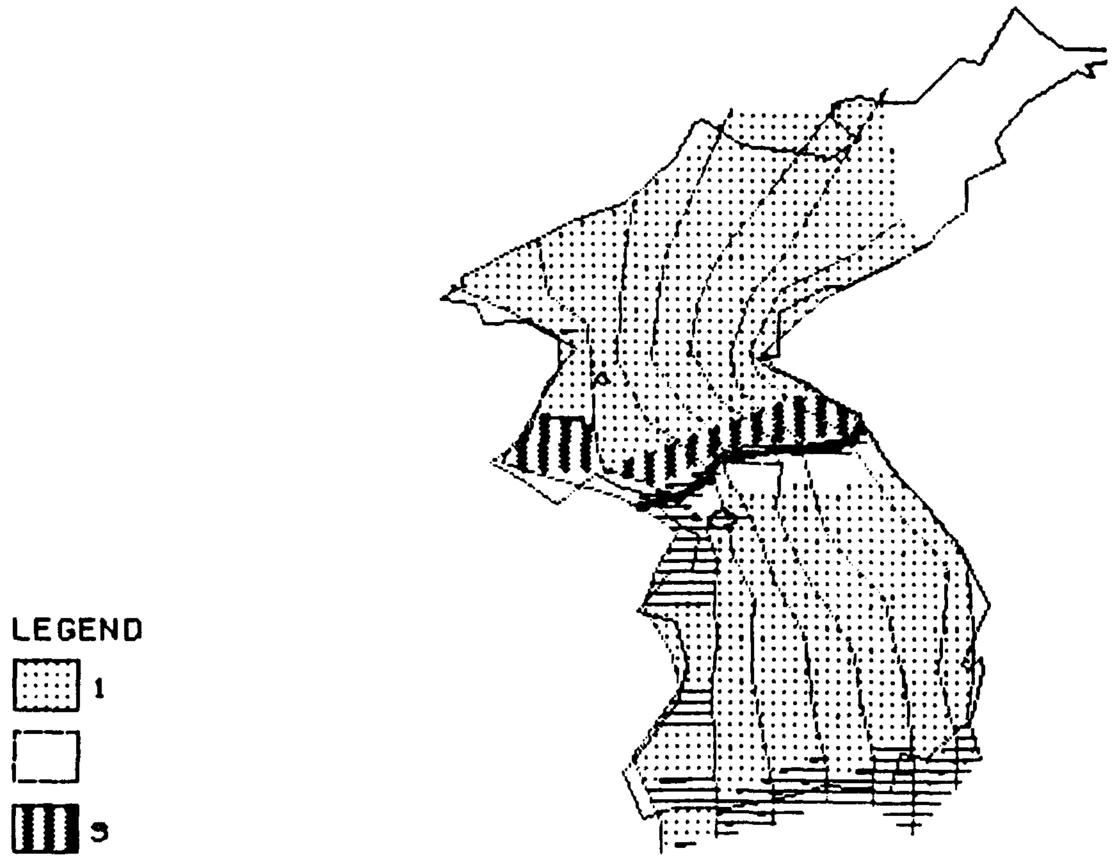
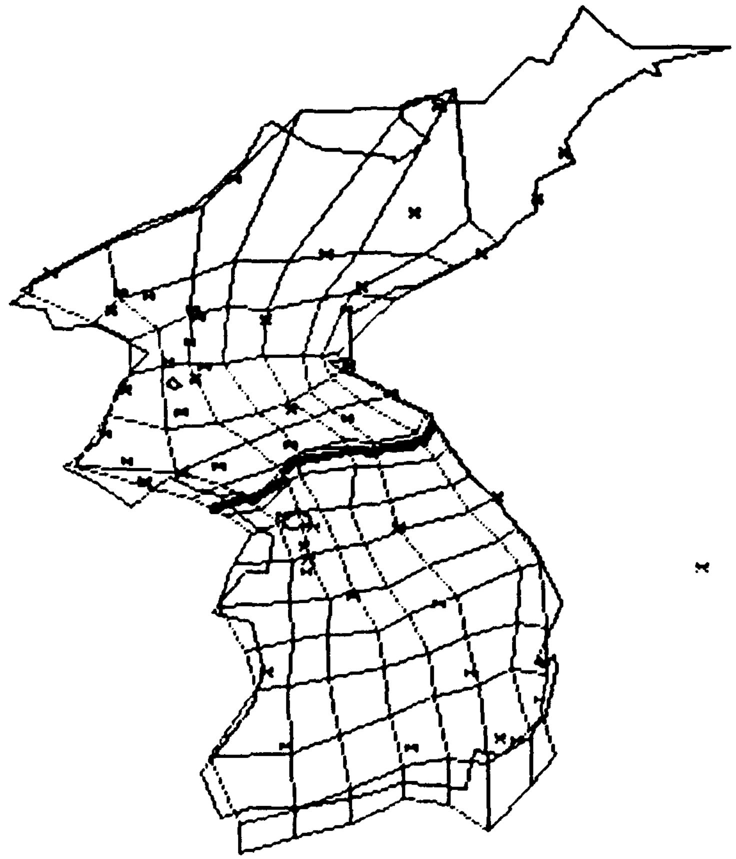
THEATER TERRAIN INTERVALS

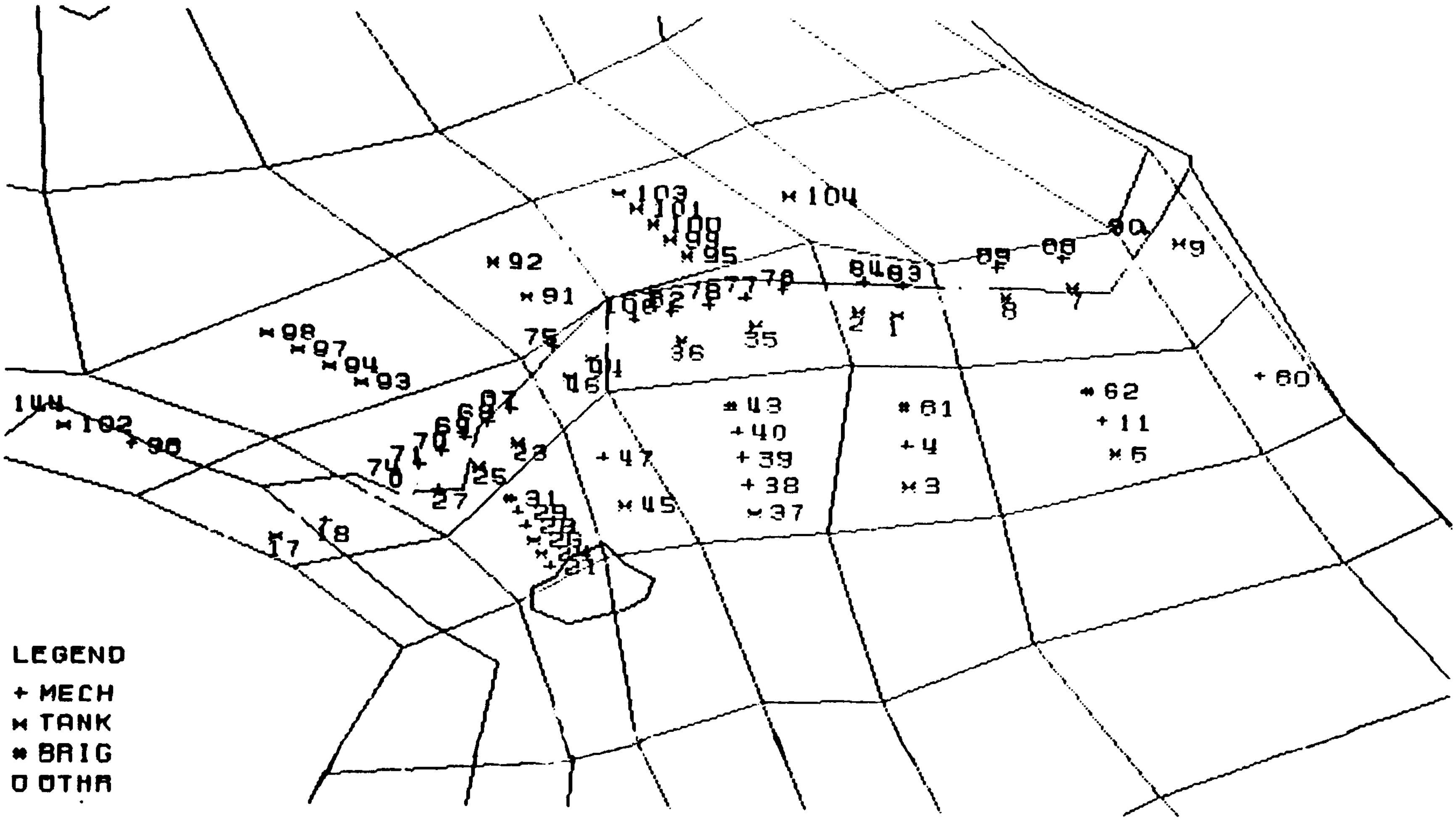
THEATER DEFENSE POSTURE



REAL AIRBASE GEOGRAPHIC LOCATIONS

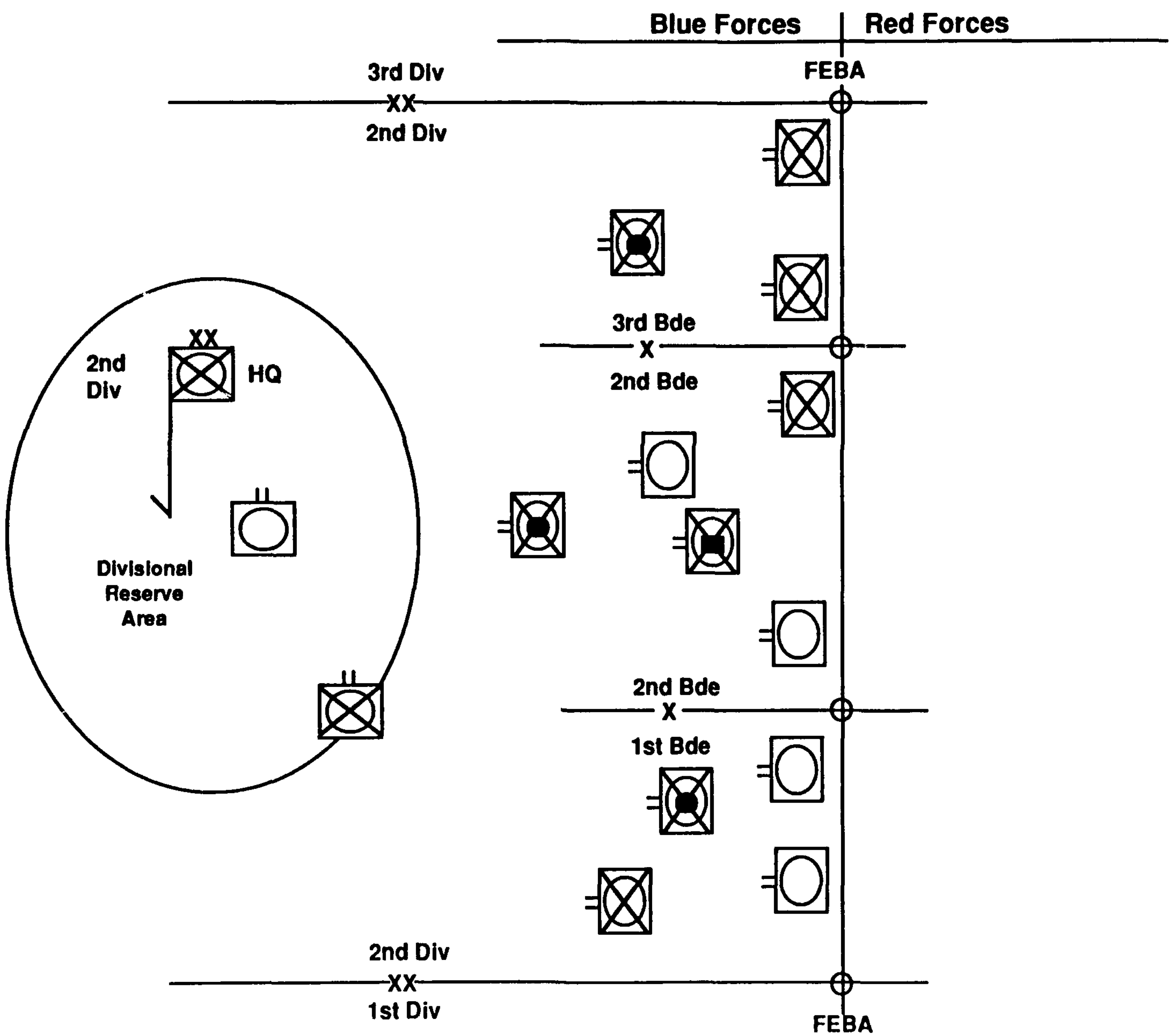


DIVISION LOCATIONS IN THEATER



An illustration of a notional deployment of Blue Forces

NOTIONAL DEPLOYMENT OF BLUE FORCES

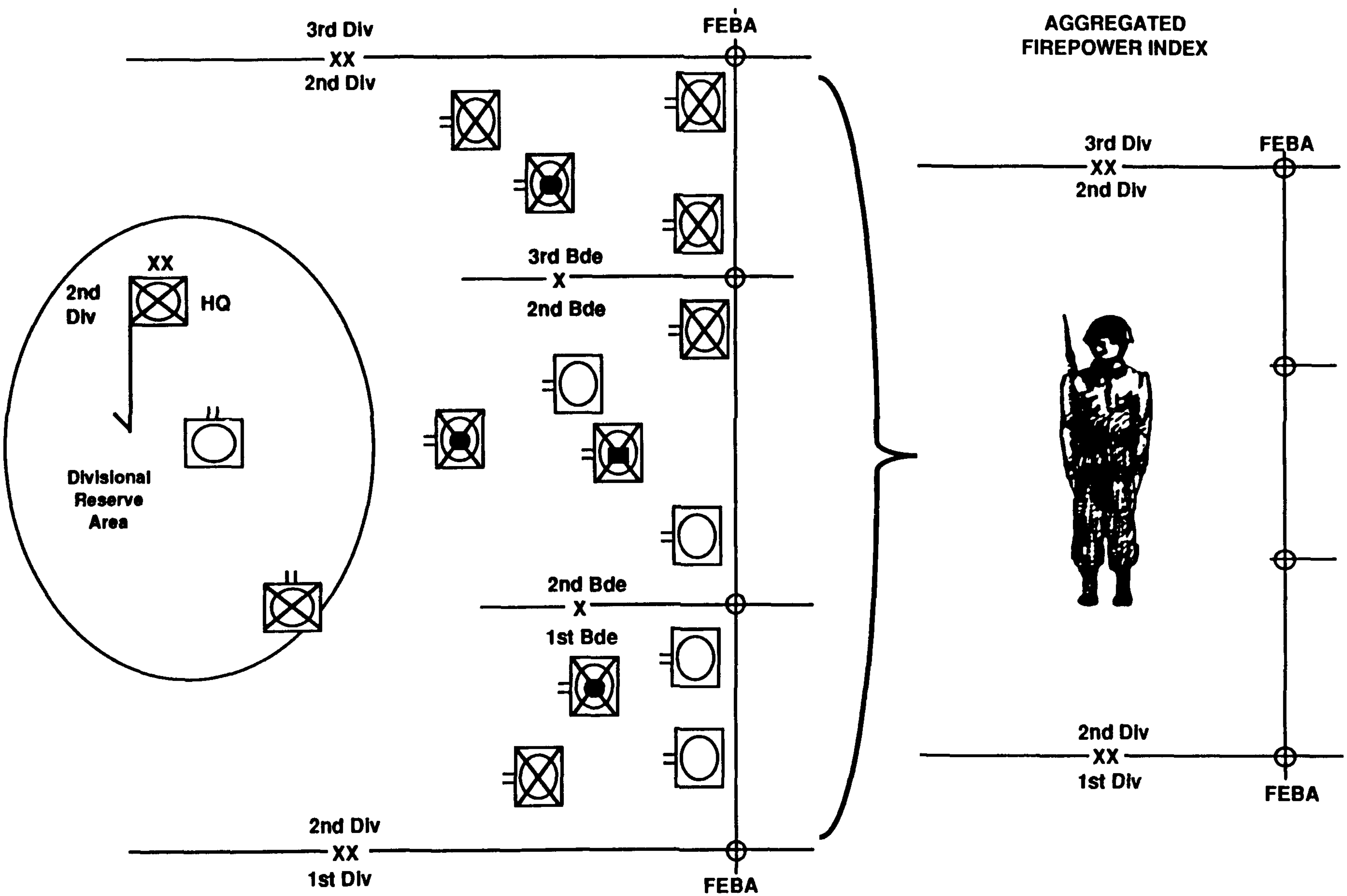


Source: GAO-PAD-80-21

NotionDeploy...

An illustration of the same portion of the notional deployment of Blue Forces in an aggregated modeling scheme

DEPLOYMENT OF BLUE NOTIONAL FORCES IN AN AGGREATED SCHEME

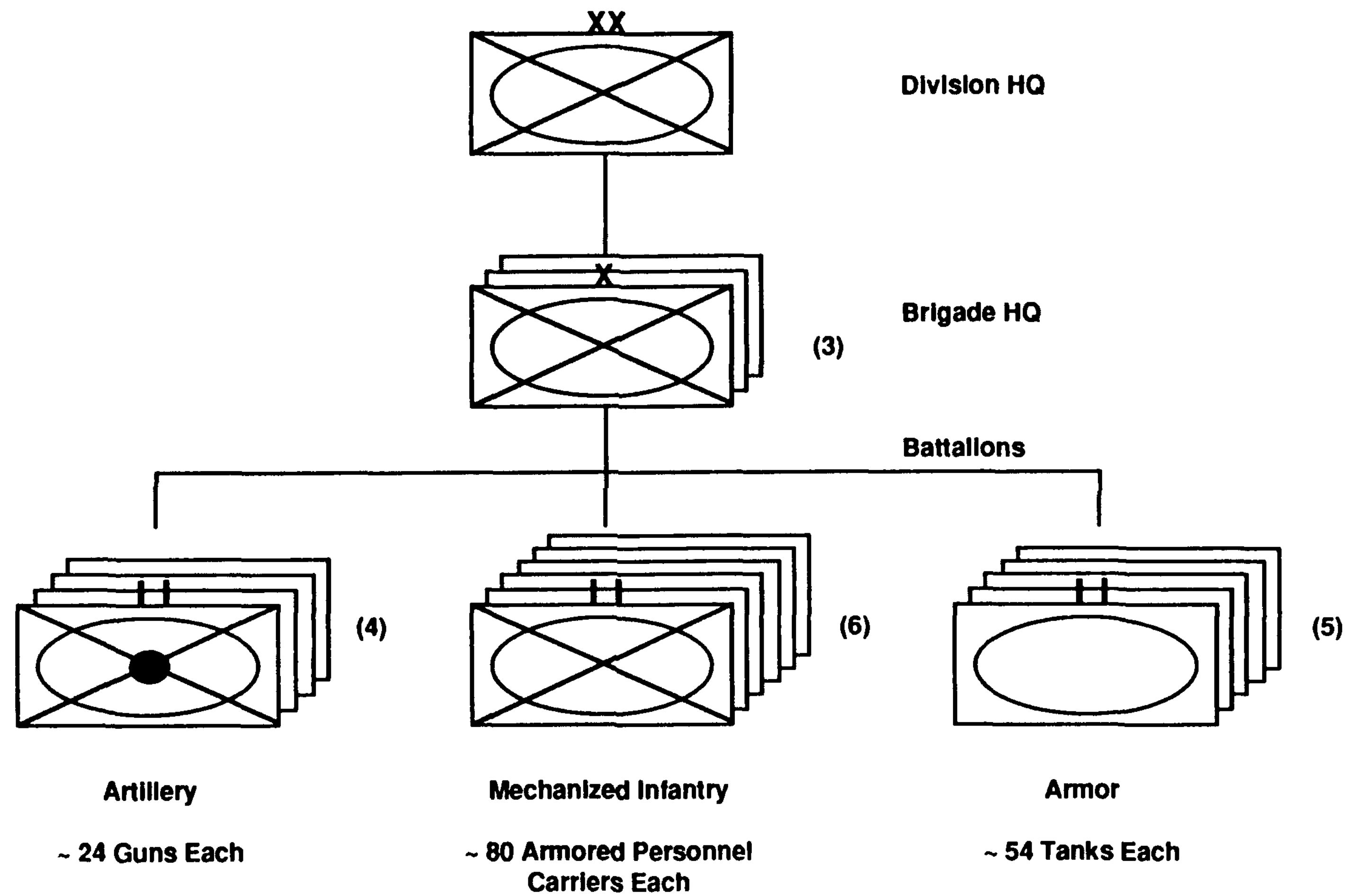


Source: GAO-PAD-80-21

DeployBlueNotional

Units in TACWAR are considered in a notional fashion with a flexible capability to adjust most of the important elements to capture a realistic representation of combat and support units.

A NOTIONAL MECHANIZED INFANTRY DIVISION



Source: GAO-PAD-80-21

NotionalMech...

Evaluation of results obtained from models might be considered as one component of a hierarchy of assessment processes. Results from modeling can be used to support weapon system trade-off analyses in conjunction with other assessments and testing results.

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A HIERARCHY OF WEAPON SYSTEM ANALYSIS

Level of Analysis	Assessments of Effectiveness	Trade-Offs
Battle		
Units Weather Topography	Casualties Weapons Attrition Movement Rates	Numbers and Types of Units Unit Tactics
Encounter		
Multiple Weapons Types Ceiling and Visibility Terrain	Targets Killed per Day and Sortie Exchange Ratios	Weapons Mixes Sub-unit Tactics
Engagement		
Single Weapons Types	Probability of Killing a Single Target Probability of Loss to Single Attritor Type	Weapons Tactics and Design Features
Operations		
Weapon Properties	Endurance Range and Speed Fire Rate	Design Specifications
Engineering		
Weapon Configuration	Weight Power Size	Design Features

Source: Extracted from Indices of Effectiveness in General Purpose Force Analysis, The BDM Corporation, 1974

An operational overview of the entire TACWAR model structure indicates its representation of ground, air, logistics, chemical, and nuclear submodels.

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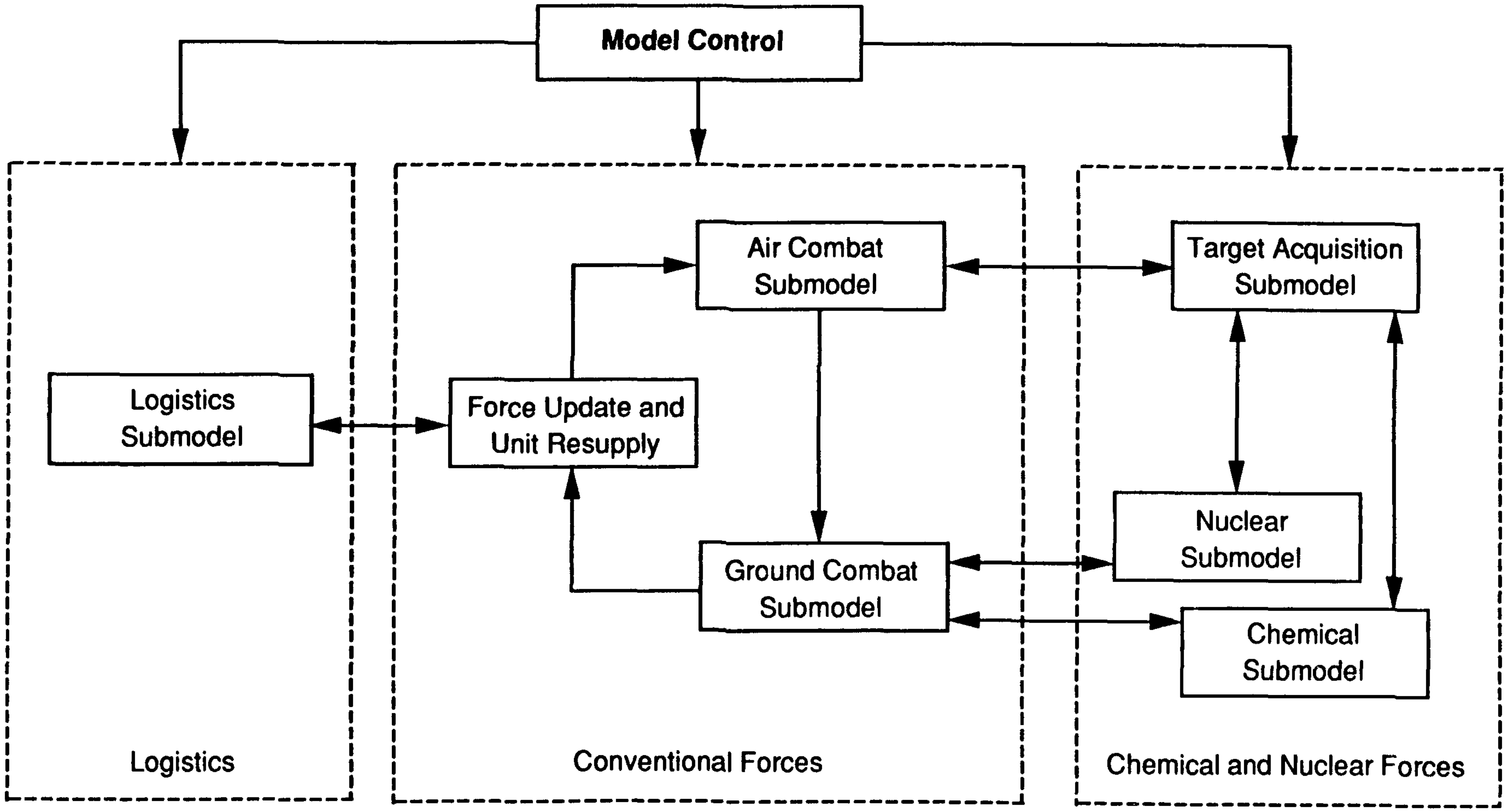
OPERATIONAL STRUCTURE OF THE TACTICAL WARFARE MODEL



OpnStructural

The briefing booklet is structured to cover some of the features of the ground combat submodel and then shift to theater considerations, followed by more detailed ground combat information.

Additional follow-on reading material is contained in Appendix B.

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GROUND COMBAT SUBMODEL AND THEATER CONTROL

- Certain operations within the ground submodel have a strong impact on theater control results.
- Because of these close tie-ins, many features of TACWAR ground combat and theater control are best discussed together as we consider a conventional warfare discussion.
- Ground combat activity for each cycle within the model follows the air combat submodel action.
- Unit and weapon conditions from cycle to cycle are matched against a standard force and then a combat effectiveness for each side is determined.
- Number of weapons, manpower, supplies, etc., are considered along with losses due to ground, air, chemical and nuclear combat (if played) to calculate weapon potentials for the remaining weapons, manpower, supplies, etc.

The data requirements for a model such as TACWAR include the following types of data.

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DATA REQUIREMENTS

(1) Theater structure data and model control factors

(2) Ground Model

-- Division characteristics
-- Weapons and weapon values
-- Movement rates
-- Casualty Rates
-- Repair Factors
-- Mobilization Schedules
-- Operational Data
-- Effectiveness parameters

(3) Air Model

-- Airbase data
-- Aircraft resources
-- SAM resources
-- SSM resources
-- Repair factors
-- Factors for Pk, Ps, Pd
-- Mission assignments
-- Weapon characteristics
-- Effectiveness parameters

(4) Chemical Model

-- Weapon characteristics
-- Munition inventory
-- Agent characteristics
-- Targeting data
-- Protection Levels
-- System locations
-- Employment data
-- Operational factors

Overview of TACWAR model data requirements (continued)

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DATA REQUIREMENTS (Continued)

(5) Nuclear Model

-- Weapon characteristics
-- Warhead inventory
-- Targeting factors
-- Protection levels
-- System locations
-- Operational factors
-- Effectiveness factors
-- Escalation levels

(6) Logistic Model

-- Supply network structure
-- Consumption rates
-- Rear area logistic structure
-- Effectiveness factors
-- Supplies on-hand
-- Operational factors

(7) Target Acquisition Model

-- Air and ground resources
-- Sensor detection capabilities
-- Operational factors
-- Target location errors
-- Time delays

Data Rqmts2

As promised, a short discussion will follow on the features of the TACWAR ground combat submodel. This will be followed by a discussion of theater-level considerations.

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TACWAR GROUND SUBMODEL

- The ground submodel can increase one's understanding of theater-level operations and force composition. Theater-level planners can gain valuable insights. The model considers:
  - Force composition
  - Geographical settings
  - Weapon performance
  - Military tactics and strategies
- Submodel outcomes should be used as trends. Battle outcomes should be used with caution to indicate direction and relative improvements due to forces and tactics.
- Small unit tactics and weapon system performance are obscured by the scale of the submodel.
- The richly detailed force structure data file containing many user-adjustable features and the ability to make changes to the input parameters is a powerful feature of TACWAR.

Some of the TACWAR ground submodel characteristics

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GROUND SUBMODEL CHARACTERISTICS

- Modeling ground combat is intrinsically complex.
- TACWAR ground combat is modeled deterministically.
- Abstractions and approximations of combat are made within models via generally accepted conceptual and mathematical surrogates.
- To an experienced combat arms field officer, theater-level combat is modeled in a very aggregated fashion.
- Division-sized units from two sides oppose each other in various active battle areas across the theater.
- The ebb and flow of a line of contact between the forces, i.e., Forward Line of Own Troops (FLOT) or Forward Edge of the Battle Area (FEBA) is a major output measure of the ground submodel.
- The movement of the FLOT/FEBA on an area-by-area basis is a function of opposing forces ability to exact attrition on each other and the inherent mobility of the combat forces.

GndSubModChar

An overview of TACWAR ground combat losses methodology

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GROUND COMBAT SUBMODEL LOSSES

- For each cycle, input data values (obtained from historical and analytical sources) are used to determine from calculated force ratios the expected losses to the ground units.
- Losses occur when combat units interact in the battle areas across the theater.
- Motion of the FLOT/FEBA is a function of the weapon potentials, supply levels, position in the sector, etc., in force ratio calculations.
- Temporary calculations are stored until constraints such as allowable flank exposure *are checked.*
- The final FLOT/FEBA trace in each sector is passed to the theater control submodel along with personnel and weapon losses.
- The theater control submodel will adjust the status and position of units depending upon the availability of reinforcements and the new FLOT/FEBA trace.

Bullets are always of interest when studying combat operations

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ACCOUNTABILITY OF MUNITIONS IN TACWAR

CURRENTLY

- Surface-to-surface missiles - six munition types for each SSM
- Tactical Aircraft
  - On close air support - six munition types for each aircraft type
  - On interdiction - six munition types for each aircraft type
- Surface-to-air missiles - one munition for each SAM type
- Air defense artillery - one munition for each ADA type

PLANNED

- Direct and indirect fire ground weapons - n-munitions for each type
- Tactical aircraft
  - On airbase attack - six munition types for each aircraft type
  - Air-to-air combat - four munition types for each aircraft type

TACWAR ground combat submodel considerations

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GROUND COMBAT SUBMODEL - TACWAR

RESOURCES

- Division-, Brigade-, or Regiment-sized units
- People, weapons, and supplies for each unit
- Weapons: direct fire, indirect fire, and air defense
- Subunits: ground units: company, battery, headquarters, etc.

TACTICAL POSTURES

• *Delay*	• *Prepared position*	• *Hasty defense position*
• Barrier	• Breakthrough	• Holding defense

CALCULATIONS

- Weapon-on-weapon and CAS air munition lethality potentials
- People, weapons, supply losses from ground and air attacks
- Movement based on type units, opposing forces, and terrain
- Supply consumption based on unit type and tactical posture
- Unit effectiveness based on people, weapons, supplies, and degradation

Overview of data for ground combat submodel

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DATA FOR GROUND COMBAT SUBMODEL

- Number and type of combat units to be played for each side
- Location of available combat units
- Mobilization or arrival schedule for follow-on forces
- Subunit structure of combat units
- Personnel and weapons complement of subunit types
- Weapon effectiveness and allocation values (one-on-one)
- Weapon damage, recovery, and repair values (by weapon type)
- Impact of chemical and nuclear strikes on unit movement
- Degradation to combat effectiveness from chemical protection (MOPP) gear

Examples of weapons that have been considered in TACWAR ground combat

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TYPICAL WEAPON TYPES

Tank	IFV
Armored Recon Vehicle	Small Arms
Anti-Tank Weapon	Helicopters
Artillery	SHORADS
Mortar	SAMs
APC	SSMs

Examples of the level of tactical situations (postures) that have been given consideration in TACWAR ground combat

TACTICAL SITUATIONS (POSTURE)

- **Attack/delay**
- **Prepared defense**
- **Hasty defense**
- **Barrier**
- **Breakthrough**
- **Holding**

Combat effectiveness is calculated to be the minimum function of a unit's weapon status, personnel status, and/or supply status.

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COMBAT EFFECTIVENESS

- **Minimum function of the number of a unit's weapons, personnel, and/or supplies available each cycle.**

Losses for each combat cycle (normally a 12-hour cycle of <u>equal</u> daylight and night-time conditions. This means that the two cycles of a day are considered equal, i.e., no allowances for day, night consideration of modeled combat) are calculated to determine the current weapon, personnel, and supply status.

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LOSSES

- Each sector is computed in sequence
- Separate input values for attack and defense are allowed for:
  - -- Weapon values (PKs)
  - -- Standard allocations
  - -- Engagement rates

Based on the force ratios and other factors listed, the amount of FLOT/FEBA movement per cycle is calculated.

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FLOT/FEBA MOVEMENT

Factors used to compute FLOT/FEBA movement:

- Force ratios
- Terrain
- Flank exposure constraints
- Posture
- Mobility

An aggregated list of supply resources for ground combat is normally considered.

SUPPLY RESOURCES

Supplies (when played) usually include:

- **Ammunition**
- **POL**
- **Other/general**

If desired, a fairly rich mix of combat service support unit considerations may be played in a TACWAR run.

SERVICE SUPPORT UNITS PORTRAYED IN TACWAR

	UNIT TYPE	FUNCTION
1.	Petroleum unit	Class III supply
2.	Conventional ammo supply	Class V (conv) supply
3.	Heavy material supply unit	Class VII supply
4.	General supply and service unit	Class I, II, and IV supply
5.	Maintenance unit	Equipment repair
6.	Engineer unit	Engineering capability
7.	Transportation transfer unit	Ground transportation
8.	Aviation unit	Intra-Theater Air
9.	Port unit	Port terminal activities
10.	Headquarters units	C^3 functions
11.	General support unit	Corps/Army support
12.	Special ammo supply	Special weapons supply
13.	Administration unit	Administration and personnel
14.	Medical unit	Hospital and medical services

SvcSupUnits

Example of the level of detail consideration when support units are modeled

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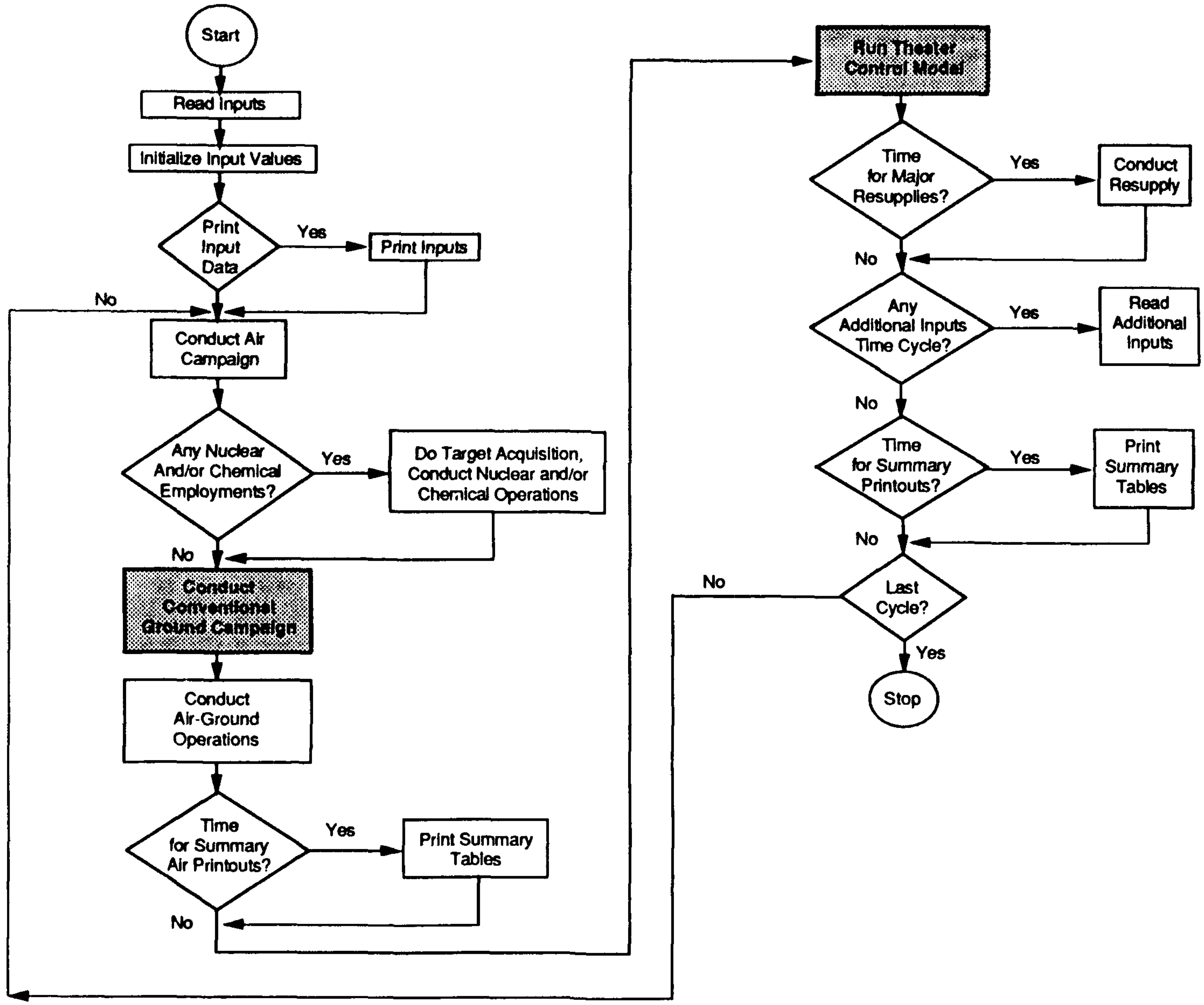
CHARACTERISTICS OF SUPPORT UNITS

UNIT TYPE	CAPABILITIES	IMPACT WHEN UNIT IS LOST
1. Petroleum company	Dispense 670k gallons/day Store 1480k gallons/day	Reduces POL resupply; impacts movement of weapons and forces; limits aircraft
2. Conventional ASP unit	Dispense 525 tons of ammo per ASP per day	Reduces ammo resupply; impacts firepower capability of combat elements
3. Maintenance company (variable size)	Provides 30 man-hours per person per week of repair capability	Reduces return to duty for weapons and equipment
4. Heavy material company	Transports 15 tanks/day and 66 tons of CL VII	Reduces the number of replacement weapons available and major end items
5. Transportation company	Transports 5000 tons per day and stores 1600 tons of general supplies	Reduces availability of general resupply; impacts unit combat effectiveness
6. Engineer company	Provides bridging and barrier capability	Impedes mobility of friendly forces; fails to delay enemy forces

CharOfSupUnits

In brief, a theater-level tactical warfare conflict is represented by the TACWAR model (the model is doing the bookkeeping for the analyst) based on the input data supplied as a representation of the theater of interest. Model assumes many representations and idealizations of combat.

TACWAR FLOW DIAGRAM



FlowDiagram1

TACWAR input variable estimates are on the following pages.

IDA

TACWAR INPUT VARIABLE ESTIMATE

	Number of Variables (Approx.)
GROSS ESTIMATE OF TACWAR INPUT VARIABLES	1450-1500
1. Theater Structure	20-25
2. Program Control Parameters	20-25
3. Air Submodel	300
a. Aircraft characteristics	10-15
b. Aircraft identifiers	15-20
c. QRA aircraft	15-20
d. Air base data	30-35
e. Repair data	10-15
f. Mission assignments	15-20
g. Munition data	20-25
h. SAM resources	20-25
i. Operations	15-20
j. Mission data	20-25
k. Parameters and factors	20-25
l. Probability of detection	20-25
m. Probability of kill and suppression	15-20
n. Air base miscellaneous	15-20

InputVarEst1

TACWAR INPUT VARIABLE ESTIMATE (Continued)

	Number of Variables (Approx.)
4. Ground Submodel	250
a. Division characteristics	15-20
b. Division effectiveness	15-20
c. Unit arrival data	10-15
d. Division subunits	15-20
e. Operational data	30-35
f. Resources	15-20
g. Weapon value	20-25
h. Movement	15-20
i. Casualties	10-15
j. Factors	15-20
k. Repair data	15-20
l. Identifiers	15-20
5. Supply Submodel	200
a. Supply node data	20-25
b. Planned supply levels	55-60
c. Consumption rates	25-50
d. Miscellaneous	55-60

IDA

TACWAR INPUT VARIABLE ESTIMATE (Continued)

		Number of Variables (Approx.)
6.	Target Acquisition Submodel	80
a.	Sensors	15-20
b.	Operational data	20-25
c.	Identifiers	15-20
d.	Attrition	5-10
e.	Error data	5-10
f.	Detection	5-10
g.	Factors	5-10
h.	Weather, terrain, visibility	5-10
i.	Time delay	5-10
j.	Optional	5-10
7.	Nuclear Submodel	140
a.	Nuclear weapons	15-20
b.	Operational data	15-20
c.	Targeting	15-20
d.	Weapon characteristics	15-20
e.	Nuclear escalation	35-40
f.	Personnel damage assessments	15-20
g.	Weapon launcher locations	10-15
h.	Personnel protection categories	10-15
i.	Vulnerability numbers	5-10
j.	Warhead inventory	5-10

InputVarEst3

IDA

TACWAR INPUT VARIABLE ESTIMATE (Continued)

	Number of Variables (Approx.)
8. Chemical Submodel	220
a. Weapon system data	25-30
b. Identifiers	5-10
c. Weapon launcher locations	10-15
d. Warhead inventory	5-10
e. Operational data	15-20
f. Chemical escalation criteria	30-35
g. Weather	10-15
h. Chemical agent data	25-30
i. Targeting data	20-25
j. Chemical protection	20-25
k. Contamination	5-10
l. Warhead data	30-35
9. Echelon Above Divisions (EAD)	125
10. Surface-to-Surface Missiles	150

InputVarEst4

ON THE FOLLOWING PAGES:

TACWAR theater considerations.

- -

In order to obtain a more visual appreciation of the theater-level combat within TACWAR, several examples of theater situations are presented. These are followed by a discussion of (1) how to start an analysis of a new geographical area, and (2) features of the theater control within TACWAR.

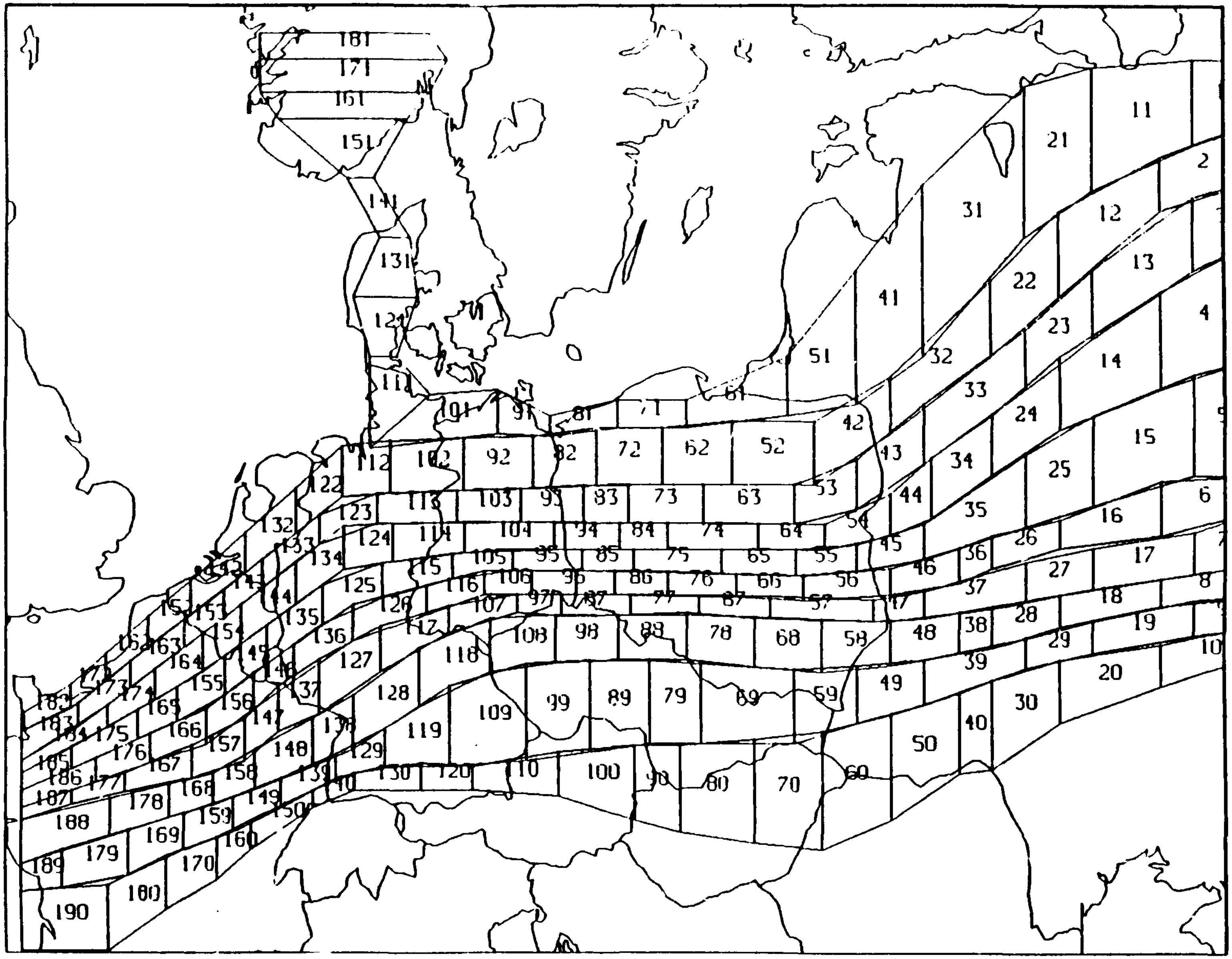
The briefing booklet then presents a few details of ground combat modeling and closes with a listing of unclassified and classified reports that could be helpful to a first-time user of TACWAR.

- -

Three examples of theater structures that have been used with TACWAR.

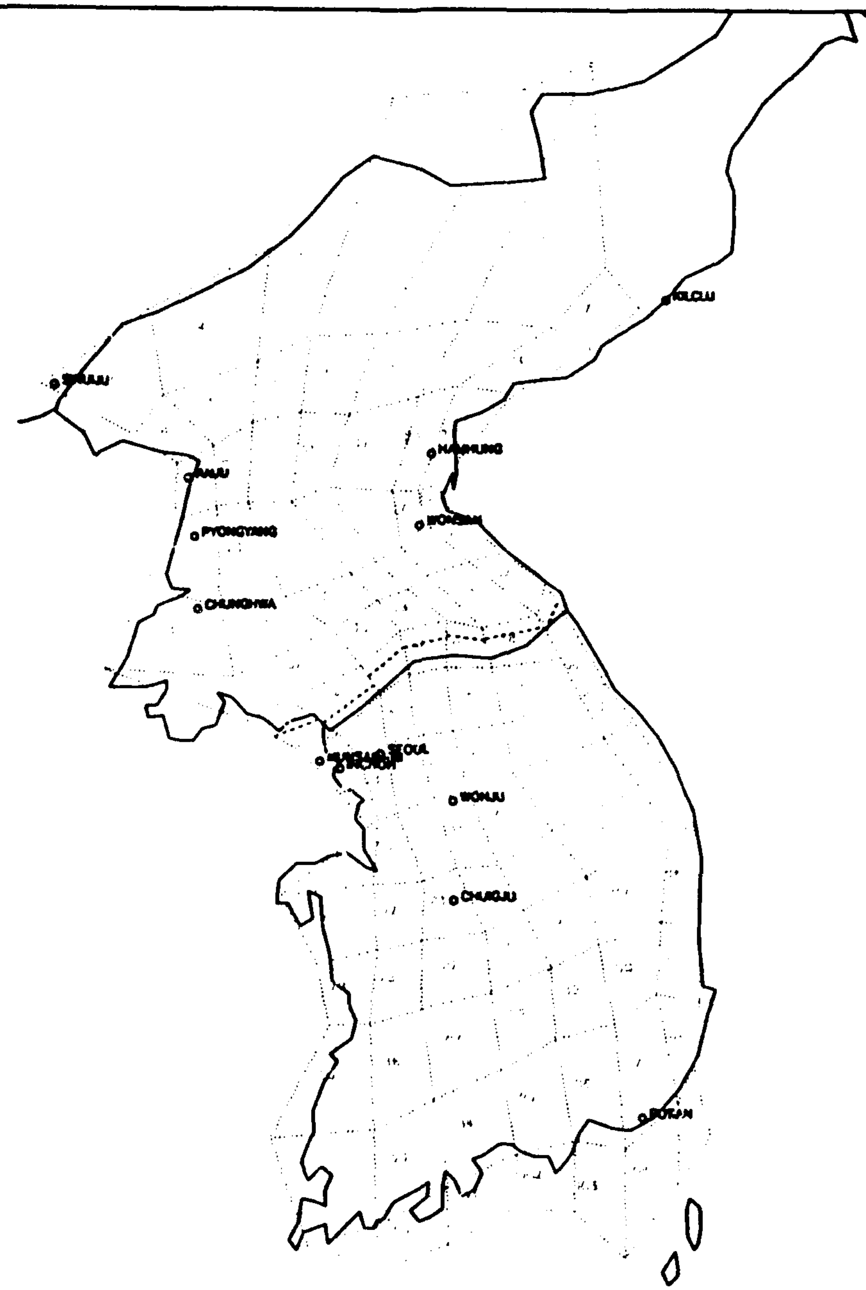
IDA

THEATER STRUCTURE



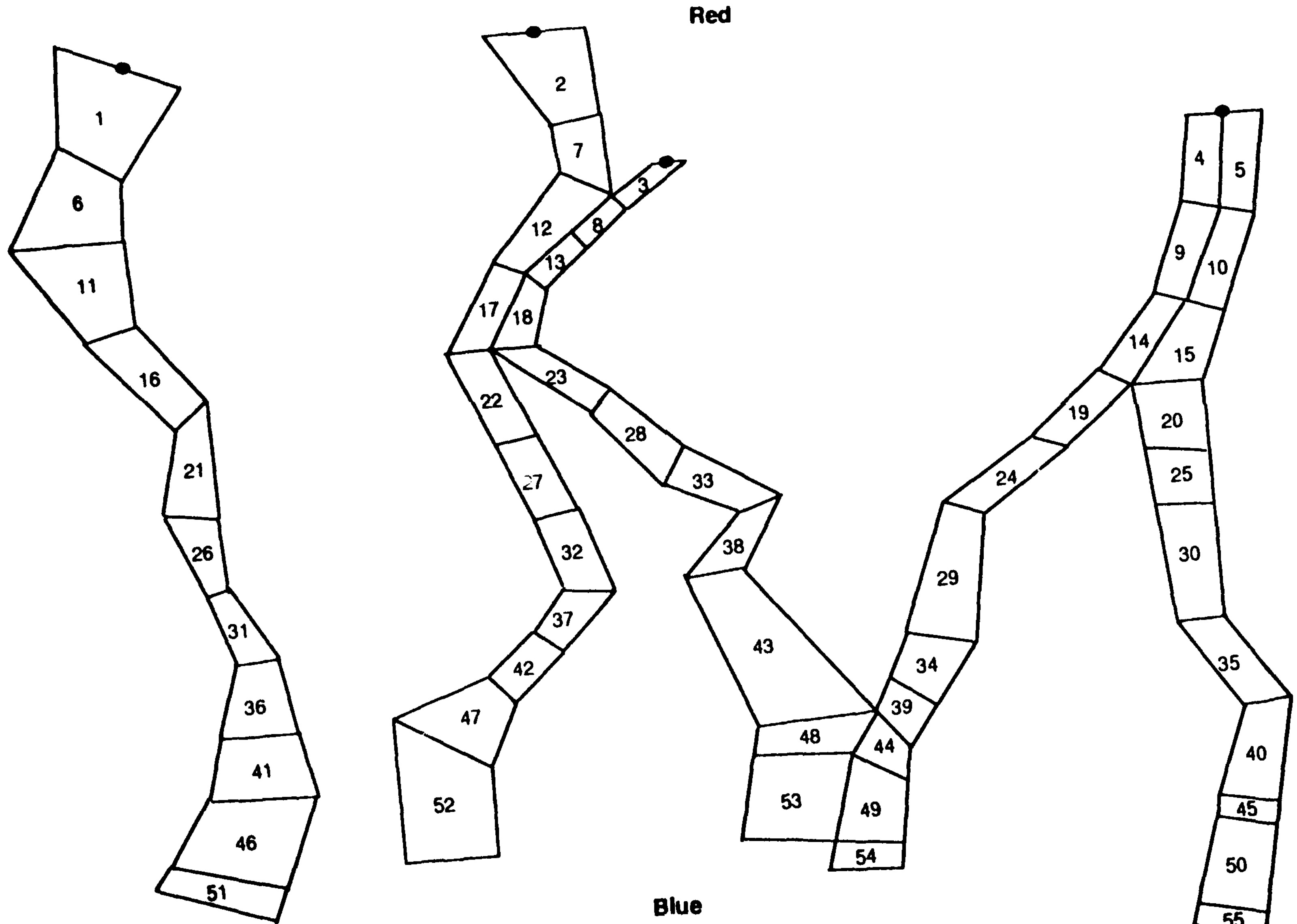
Map-TheaterStruc

MAP LOCATIONS



MapLocations

EXAMPLE OF NONCONTIGUOUS THEATER SECTORS



ExampleNTSPlain

Structuring TACWAR theaters is an extremely important part of any study. TACWAR theater structuring must be done during the initial stages of any study where a theater data base is unavailable.

IDA

STRUCTURING TACWAR THEATERS

Extremely important early studies:

- Components of a TACWAR theater structure
  - -- Sectors
  - -- Battle Areas
  - -- Intervals
  - -- Regions
  - -- COMMZ
  - -- FLOT/FEBA
- Raw materials
  - -- History
  - -- OPLANS
  - -- Maps
  - -- Aerial Photographs
  - -- Satellite Photographs
  - -- IR Scans
  - -- SLAR Scans
- Theater features
  - -- Rivers
  - -- Mountains
  - -- Forests
  - -- Built-Up Areas
  - -- Avenues of Approach
  - -- Air Bases
  - -- Lines-of-Communications (LOCs)

Theater geography and parameter considerations

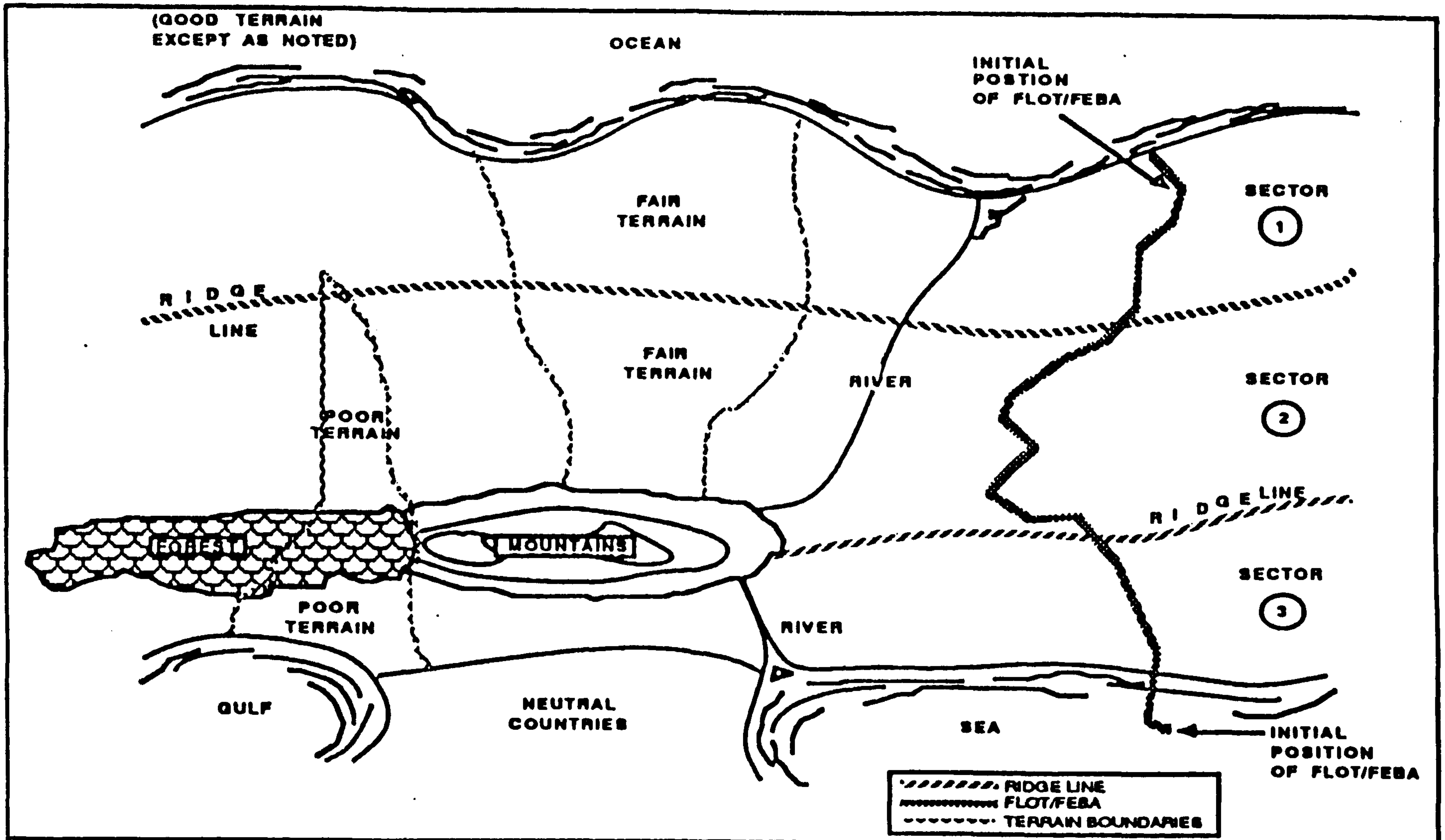
IDA

THEATER STRUCTURE, GEOGRAPHY, AND CONTROL PARAMETERS

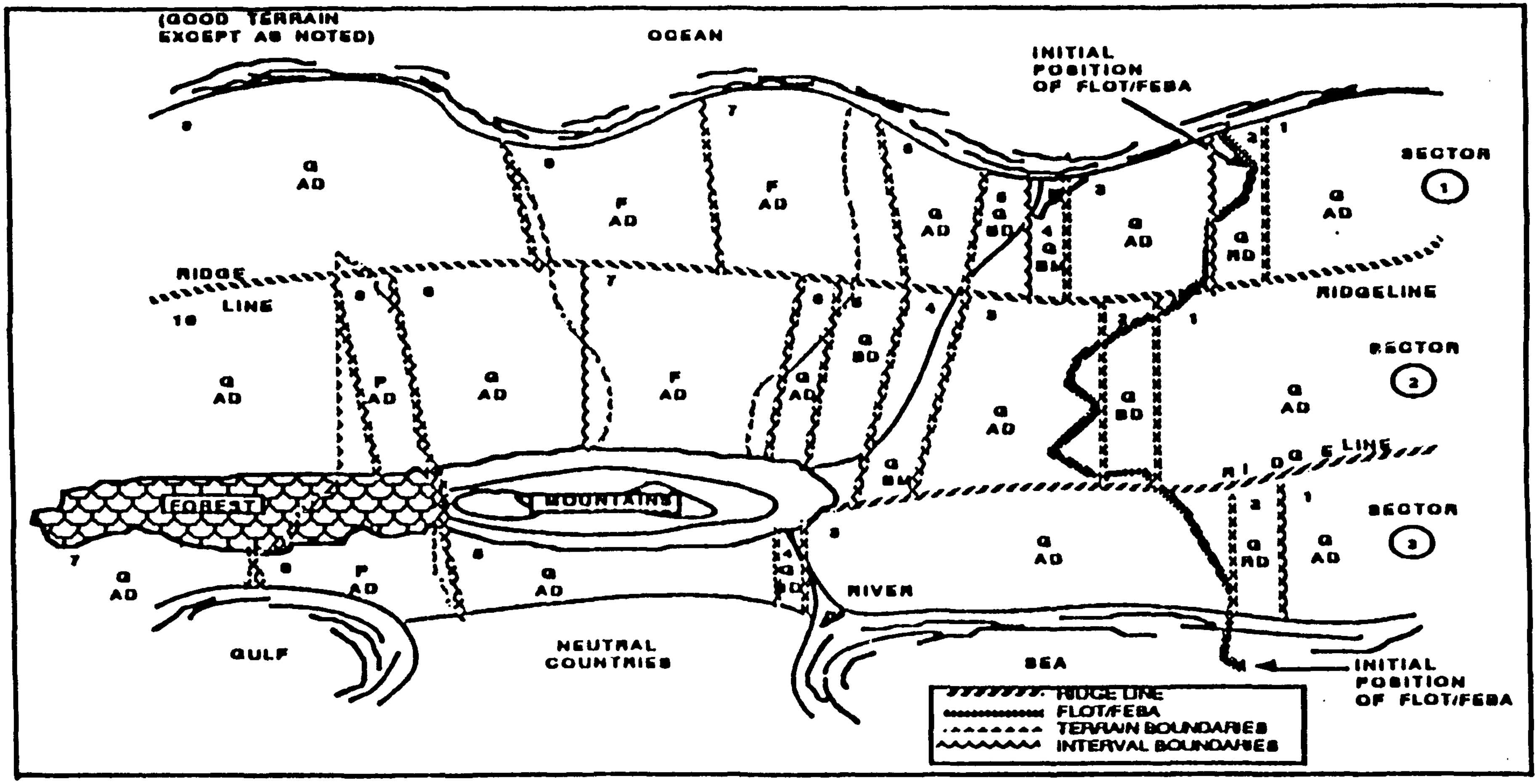
- Theater area of interest (area of expected combat engagements)
- Terrain types throughout area of interest
- Postulated avenues of advance and combat objectives
- Natural or man-made barriers restricting movement
- Number and location of corps areas
- Area of influence for tactical air forces/naval TACAIR
- Civilian population distribution by city size and rural areas
- Distribution of civilian population into physical protection levels
- Combat unit movement rates in theater areas of interest
- Combat unit casualty rates in theater areas of interest

The following four slides show a fictitious geographical area that illustrates some of the features important in theater structuring.

EXAMPLE OF A GEOGRAPHIC AREA

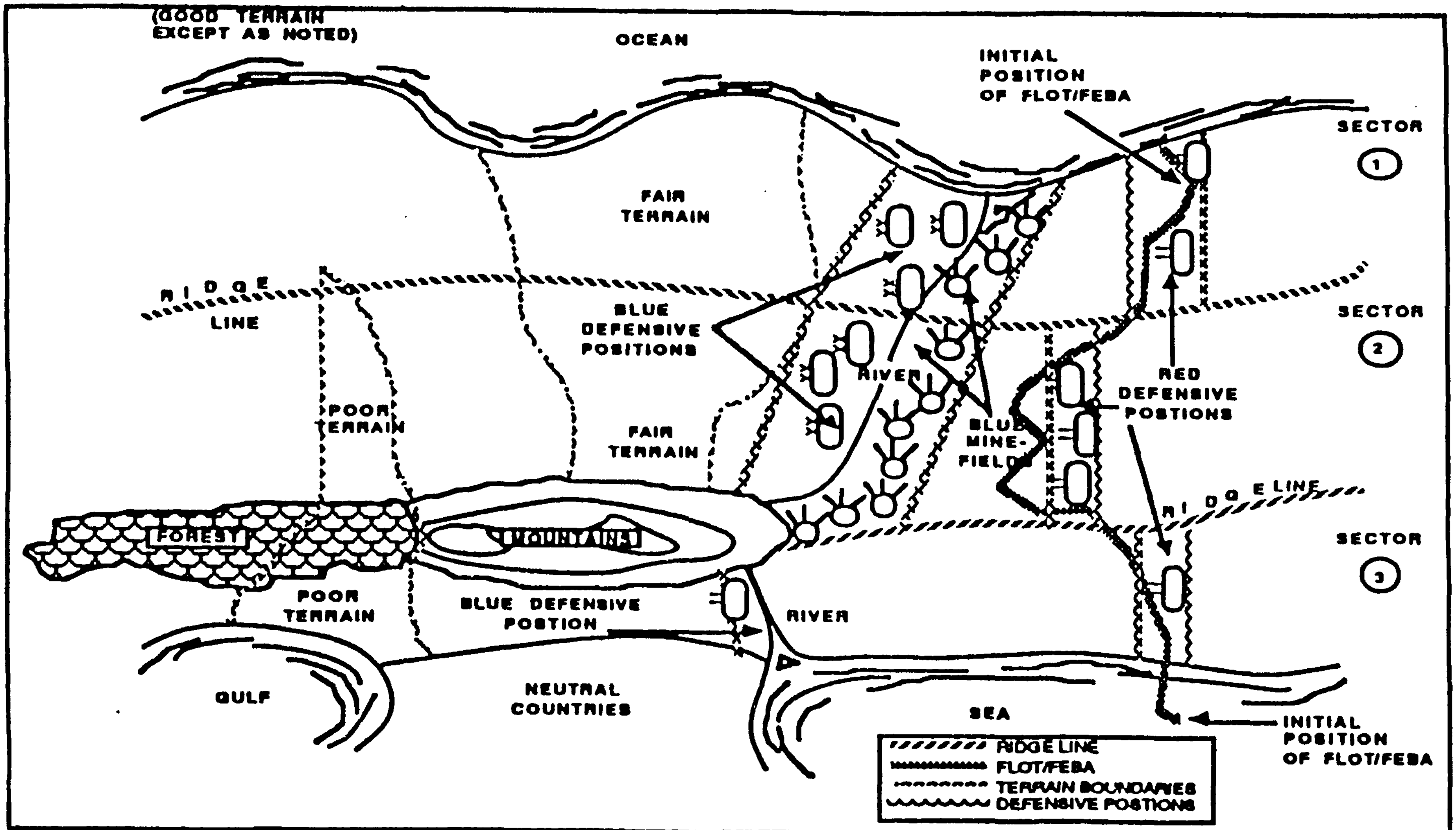


EXAMPLE SHOWING INTERVAL BOUNDARIES

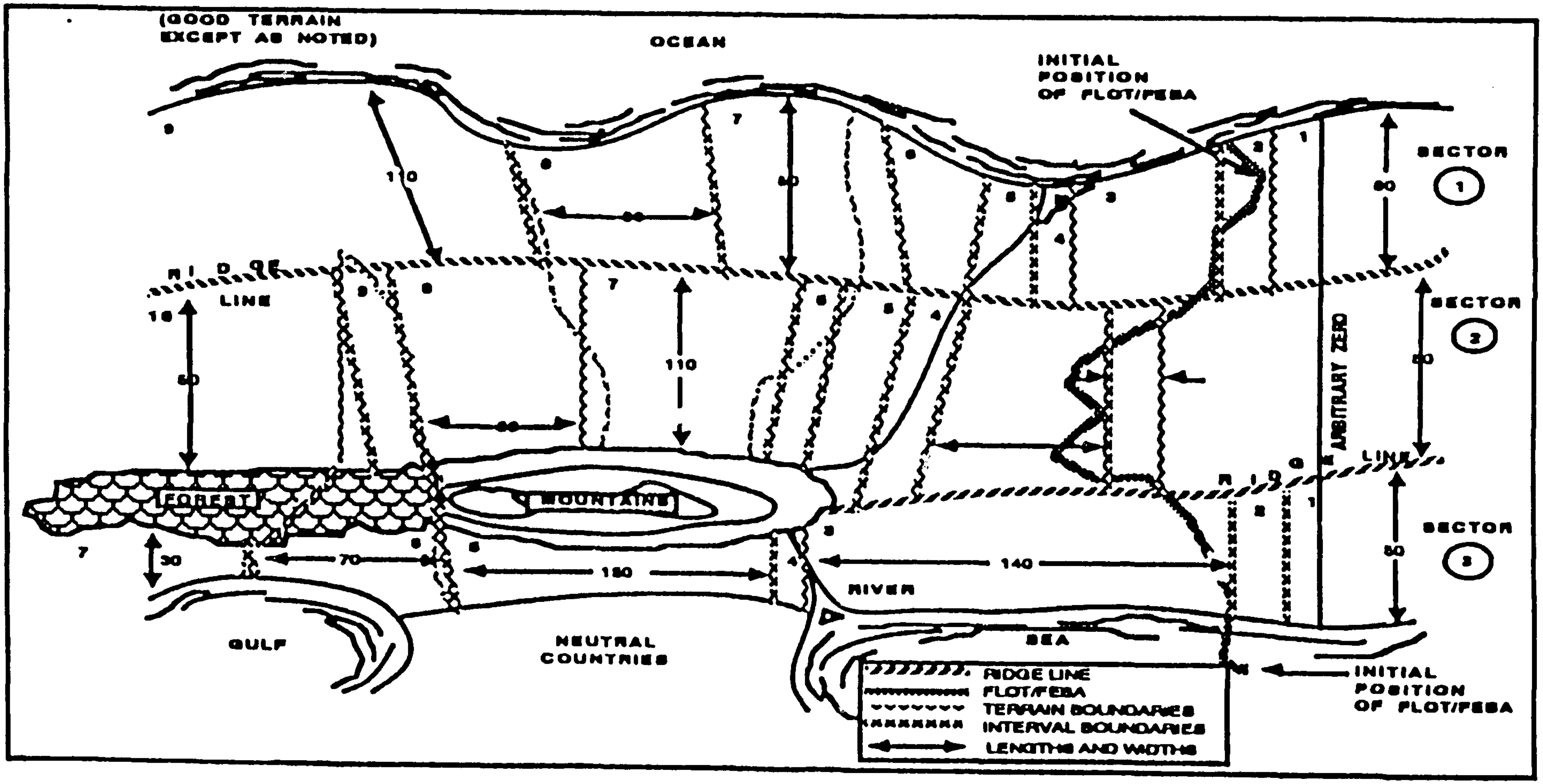


ExamIntervalBoun

EXAMPLE SHOWING DEFENSIVE POSITIONS AND LAND MINEFIELDS



EXAMPLE SHOWING INTERVAL LENGTHS AND WIDTHS



IDA

THEATER STRUCTURE

(1) SECTORS

- Correspond to ground model sectors
- Contain notional airbases (F, R)
- Contain pools of aircraft
- Contain close air support (CAS) and interdiction (Int) targets

(2) BATTLE AREAS

- One Active Battle Area (ABA) per sector
- The ABA contains the FLOT/FEBA
- Ground combat takes place in the ABA between Red and Blue forces
- Battle areas have the same width as sector

(3) INTERVALS

- Concept used to represent terrain and combat posture
- Interval may be variable lengths
- Intervals are fixed at the width of the sector

(4) REGIONS

- Represent zones of operational control (may extend across one or more TACWAR sectors)
- Aircraft fly from region to region
- Subdivided into forward (F) and rear (R) areas
- Contain penetration corridors
- Contain HIMADS (belt, area SAMs)
- Contain airbase attack (ABA) targets (aggregated notional air bases)

IDA

THEATER STRUCTURE (CONTINUED)

(5) COMMZ(S)

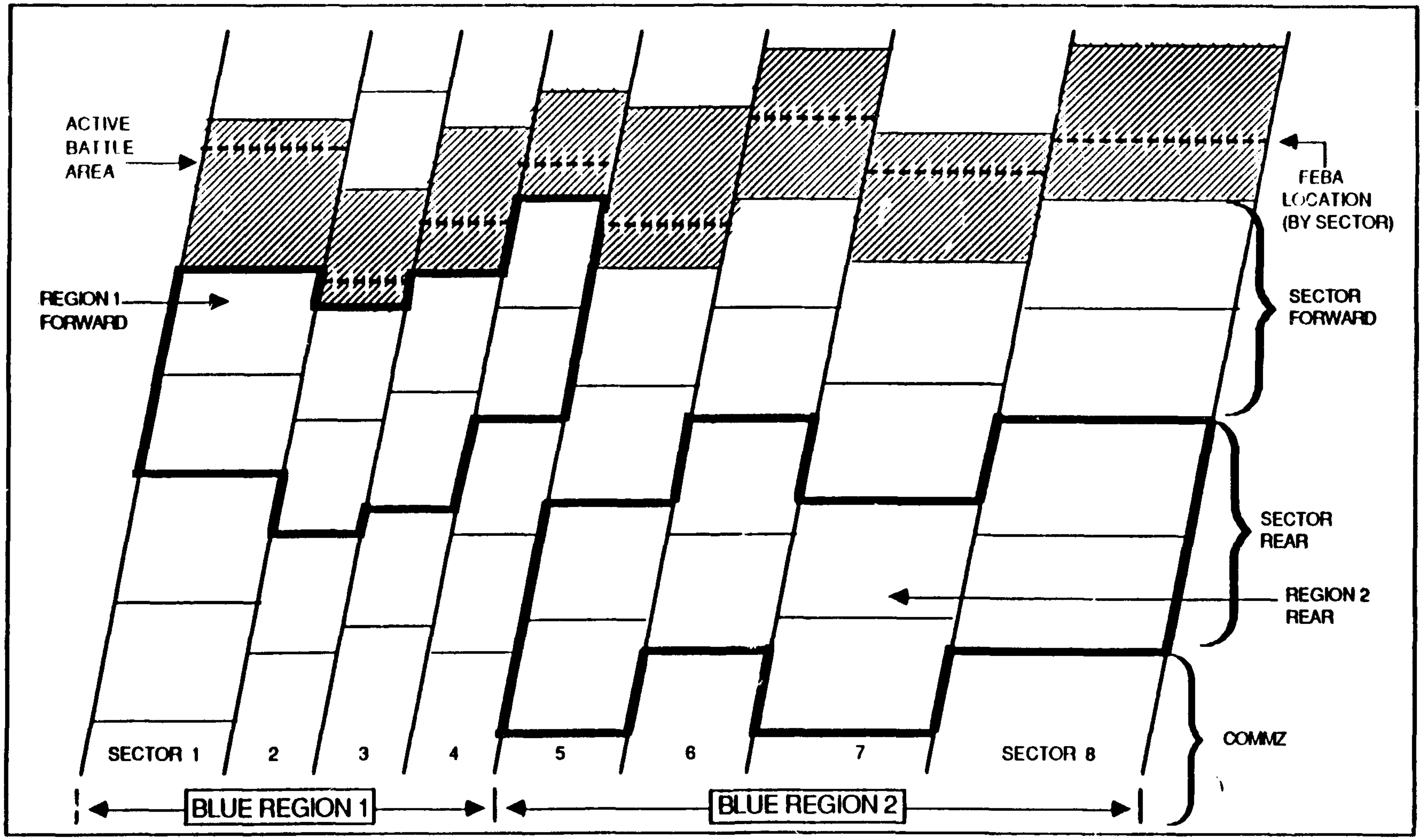
- Single notional air base per side/one per sector
- Single pool of aircraft for side/one per sector

(6) FLOT/FEBA

- Always located in ABA
- Initial position is usually a political boundary
- Represents the line that separates Red and Blue combat units
- Movement of FLOT/FEBA is a calculated output of the model

TheaterStructure2

THEATER STRUCTURE (BLUE SIDE ONLY)



Sectors are piston-like elements that extend from one end of the theater to the other. In Europe, sectors may approximate Army corps areas of responsibility. They often correspond to avenues of approach or LOCs.

COMPONENTS OF A TACWAR THEATER STRUCTURE

Sectors

-- One of the major features of a TACWAR theater representation
-- Sometimes called the "Piston" of the model
-- Each sector will run the length of the theater
-- May be of variable width
-- Represents non-intersecting bands of theater area of interest
-- Normally coincide with axes of attack
-- May be contiguous or non-contiguous
-- Sectors play an important role in the modeling of:
    ** Aircraft operations
    ** SSM operations
    ** Resupply operations
    ** Ground combat operations
-- May be subject to flank constraint conditions

Sectors are subdivided into structural modeling elements called battle areas. Every TACWAR sector in a given theater will have the same number of battle areas per sector. Combat units in TACWAR are located in a specific battle area.

COMPONENTS OF A TACWAR THEATER STRUCTURE

- **Battle Areas**

  -- Each sector of a theater contains the same number of battle areas.
  -- The Active Battle Area (ABA) contains the FLOT/FEBA and, therefore, the ground combat between Red and Blue.
  -- These ground activities are subject to attack by aircraft or SSMs.
  -- Battle areas always have the same width as their sector.
  -- Battle areas are the primary means of locating and tracking units, air bases, supply nodes, etc.
  -- Most battle areas do not participate in active ground combat; hence, the name inactive battle areas.
  -- By using USER established offsets from the FLOT/FEBA location, the fluidity of battle can be discussed in terms such as second and third echelon areas.
  -- The inactive battle areas serve as areas to locate:
    ** Reinforcements
    ** Reserve positions
    ** Supply nodes
    ** Tactical air bases, etc.
  -- Battle area depth and echelon offsets are user defined and listed as distance from a reference line representing the edge of the theater for battle areas and distance from FLOT/FEBA for second and third echelon offsets.
  -- The active battle area will move forward or backward in the sector as determined by the combat interactions at the FLOT/FEBA.
  -- Motion can be viewed as the motion of a piston sliding in a cylinder (the sector).
  -- Checkpoints and objective positions may be represented within battle areas.

Battle Areas (Continued)

- **Limitations:**
  - -- Cannot model special forces such as SPETZNATS or amphibious assault operations behind enemy lines.
- **Locating Battle Areas:**
  - -- The location of a battle area is provided as coordinates which are the latitude and longitude of the four *corners* of the battle area.
  - -- The shape of a battle area does not have to be rectangular but must be a four-sided convex set.
  - -- Thus, a string of battle areas will stretch from one end of the theater to the other within a sector.
  - -- Battle area numbering follows a regular scheme where the numbers increase across each sector boundary.
  - -- Each row or sector must have an equal number of battle areas.
  - -- Dummy battle areas may be used to preserve the numbering scheme.
  - -- The numbering scheme does not use compass directions.

A third structural element of a TACWAR theater is known as an "interval."

IDA

COMPONENTS OF A TACWAR THEATER STRUCTURE

Intervals in Sectors

-- *Terrain and selected defensive positions are represented by a concept of intervals.*

-- Interval determination is next in importance to sector determination.

-- In determining intervals, consideration must be given to:

- Rivers
- Mountains
- Lakes/swamps
- Minefields
- Cities

-- The intervals may be as long or short as needed to represent terrain and posture. The interval coded value is predominant to the entire width of the sectors that are *coincident*.

-- Examples:

Terrain Type (KTERIS)

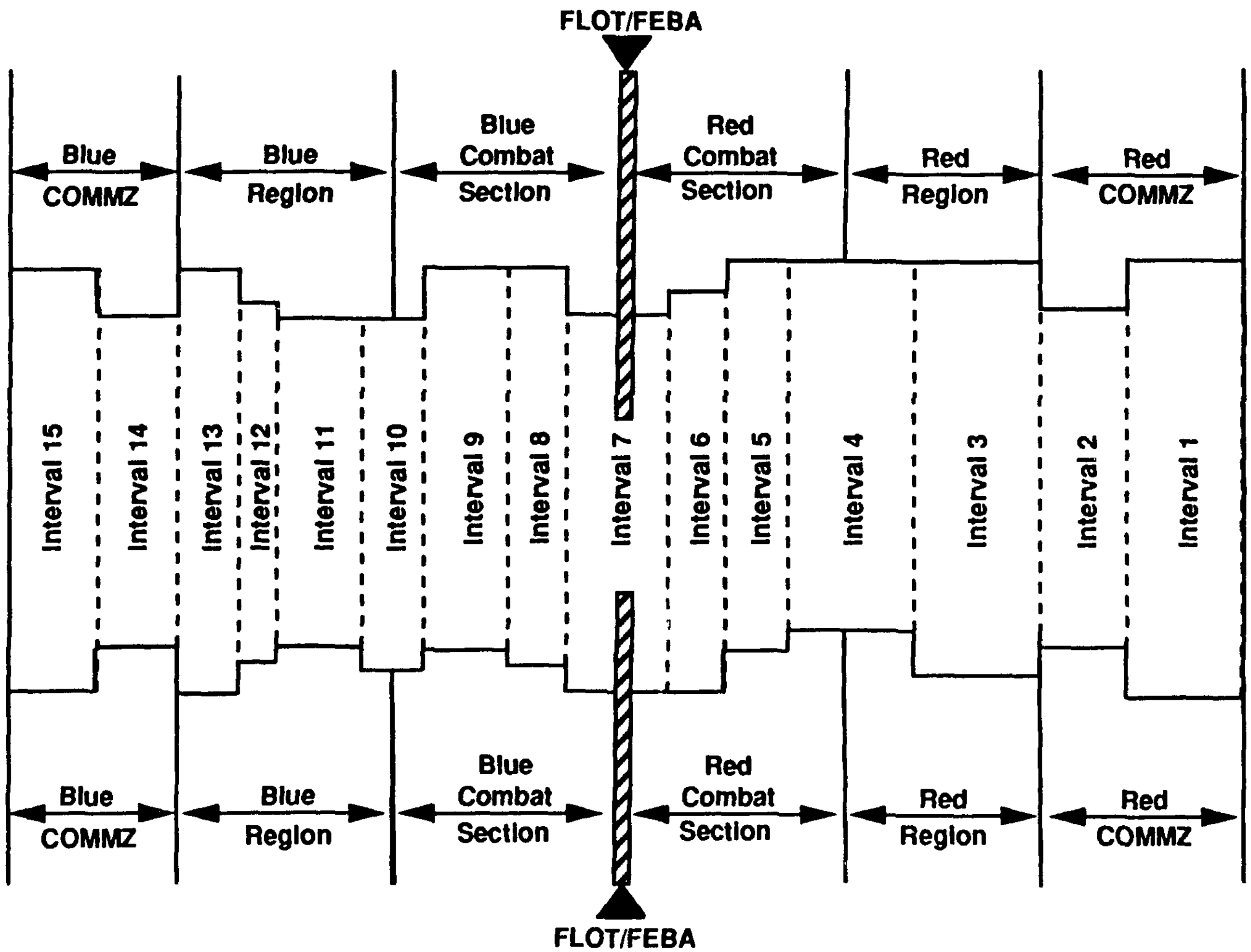
1 = Good terrain
2 = Fair terrain
3 = Poor terrain

Posture Type (KPIS)

1 = Attack Delay
2 = Hasty position
3 = Prepared position
4 = Barrier
5 = Breakthrough
6 = Holding

Illustration of intervals along one sector. The number of intervals per sector is determined by the size allowed in the computer program. In Europe, between 18 and 40 intervals have been used per sector. Although the accompanying illustration indicates intervals of different width and breadth, the interval representation information is constant *across the entire width of* a sector.

ILLUSTRATION OF INTERVALS ALONG ONE TACWAR SECTOR



IllusIntervals

TACWAR battle areas are grouped relative to the active battle area to define TACWAR regions. The standard regions are sector forward, sector rear, and COMMZ.

COMPONENTS OF A TACWAR THEATER STRUCTURE

Regions

- Regions are a group of TACWAR battle areas.
- Regions are defined from the first inactive battle area toward the rear and are user defined in depth and width.
- The number of battle areas per region need not be the same for both sides.
- The region concept may be used in the air and supply modeling.
- Air and supply operations are not limited by terrain features of TACWAR.
- Regions more accurately depict the operational scale of aircraft and supply operations.
- Forward region goes backward from the rear of the active battle area, as far as the user specifies, usually two or three battle areas.
- Rear region stretches from the rear boundary of the forward region back as far as the user supplied depth.
- A collapse takes place as the battle advances in the theater.
- When an insufficient number of battle areas are not available to support a representation of theater combat, the model will hait.

A Communication Zone (COMMZ) for both sides is modeled at the back of the region structure.

COMPONENTS OF A TACWAR THEATER STRUCTURE

Communication Zone (COMMZ)

-- COMMZ butts up against the rear region and spans the depth of the theater.

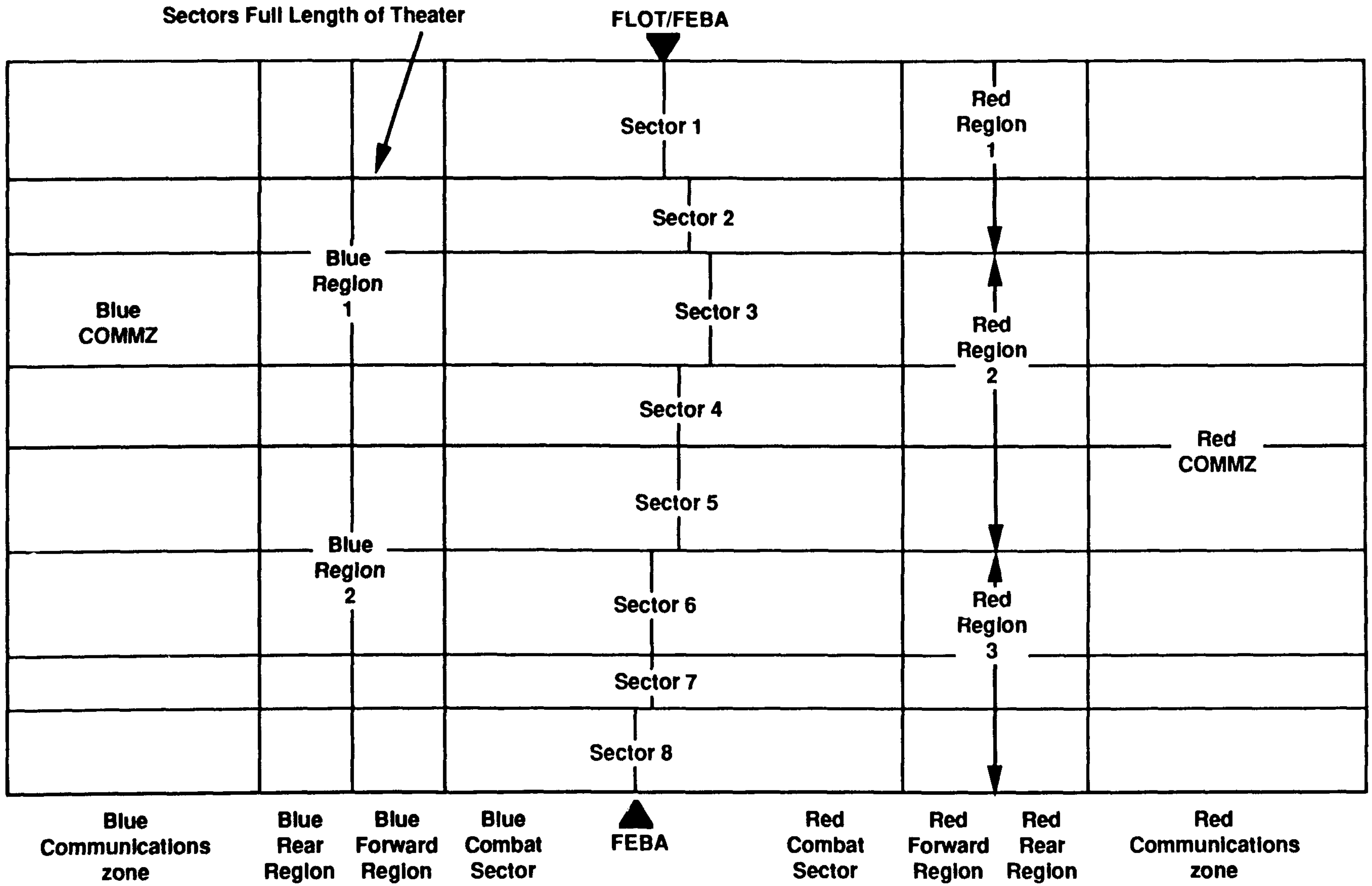
-- COMMZ is used to receive:

* Arriving units
* Tactical aircraft
* Supplies
* Replacement Weapons
* Personnel replacements.

-- COMMZ serves as a holding area for combat reserves and a base for long-range tactical aircraft.

COMMZ

ILLUSTRATION OF TACWAR BATTLE SECTORS, REGIONS, AND COMMZ



IllusBattleSectors...

IDA

COMPONENTS OF A TACWAR THEATER STRUCTURE

Forward Line of Own Troops/Forward Edge of Battle Area (FLOT/FEBA)

-- Initial location of FLOT/FEBA is provided as user input.

-- The FLOT/FEBA is usually a political boundary.

-- FLOT/FEBA is located in the active battle area and separates the Red and Blue units.

-- FLOT/FEBA movement is determined based on historical and analytical factors supplied to the model as user input and the combat force ratio calculations on a cycle-by-cycle basis.

-- Flank exposure values may be used to constrain FLOT/FEBA movement.

Six elements of TACWAR control the various ground and theater operations.

IDA

TACWAR GROUND AND THEATER

THEATER CONTROL

- Theater control regulates the various operations performed by TACWAR routines as they pertain to the submodels. This aspect of TACWAR is discussed in more detail on the slides immediately following.
- The operations listed below are described in detail after the basic operation of theater control is discussed.
  - Allocation of theater resources for attacker and defender
  - Initial deployment and assignment of follow-on units
  - Reinforcement of defensive positions
  - Calculation of combat units per sector (i.e., active battle area)
  - Calculation of replacements
  - Weapon repair operations

TheaterControl1

IDA

TACWAR GROUND AND THEATER

BASIC OPERATION OF THEATER CONTROL

(1) When the target acquisition submodel is used, TACWAR theater control first determines the assignment of reconnaissance aircraft and calculates attrition to reconnaissance aircraft.

(2) The remainder of theater control is executed regardless of whether the target acquisition model is utilized.

(3) Theater control prepares the model for the next combat cycle.

(4) Theater control determines the dynamics of each combat sector based on the current FLOT/FEBA location by battle area.

(5) The routines compute the total tonnage of supplies consumed by combat units that are located in the active battle areas, regions, and COMMZ.

(6) It then determines the sectors of main attack (if not input by the user) within each region based on opposing effective combat units.

(7) As a result of the FLOT/FEBA movement calculated in the ground combat model, the model updates the location of combat divisions and supply nodes.

(8) Then, based on the new FLOT/FEBA location, it adjusts the region forward and region rear depths, if necessary.

BASIC OPERATION OF THEATER CONTROL (Continued)

(9) Theater control computes the number of non-combat weapon losses that arise each cycle and sends the broken weapons to the repair pools. The routine conducts the operation of weapon repair and sends repaired weapons to the replacement pools. Another major activity of theater control is the relocation and upgrading of divisions for combat in the next cycle. The routine first computes the change in combat mode, if appropriate.

(10) Next, new combat effectiveness is computed for each division based on people, weapons, and supplies available in the units. Then, units are withdrawn from the active battle areas back to the second inactive battle area if they are ineffective units and replacements of units of higher effectiveness is done from the first inactive battle area, if available.

(11) For each unit in the active battle area, the model then computes its demand for replacements of people, weapons, and subunits.

(12) Theater control then assigns to these units the required replacements, provided they are available in the replacement pools. Next, the routine determines which actual air bases must be abandoned because of advancing enemy forces.

(13) Then, it computes the total supply demands of the tactical air bases and of the combat units in the rear areas, and ships supplies to requesting areas according to available inventories.

IDA

TACWAR GROUND AND THEATER

BASIC OPERATION OF THEATER CONTROL (Concluded)

(14) The theater control routine also computes the effectiveness of units and places the units in the first inactive battle area according to their effectiveness level. Next, theater control moves units from rear areas forward by the appropriate movement rate. Finally, if the present cycle is one in which the supply model is executed to distribute supplies between nodes, theater control updates the node assignments. Theater control routines perform much of the unit, weapons, and supply bookkeeping.

TACWAR GROUND AND THEATER

ALLOCATION OF RESOURCES FOR ATTACKER AND DEFENDER

- The allocation of combat resources to regions of the battlefield depends to a large extent on who is attacking and where the main attack is occurring.

- To start this routine, a user must input which side is to be the conceptual theater attacker. The initial theater defender may become a theater attacker, but only when he is either holding or able to become the attacker in all sectors.

- For each cycle, the combat value per sector determines who the sector attacker may be. This combat value is the sum of the attacker values of all combat units within (and all aircraft assigned to) a particular active battle area for one side. The side with the higher total combat value is the sector attacker for that cycle. Even though one side is the attacker in all sectors, there may be Sectors of Main Attack (SMAs) where additional resources are required. The user can set up an SMA, or the submodel logic can compute it. If the model calculates the SMA for each region, the model chooses the sector that experienced the most FLOT/FEBA advance.

TACWAR GROUND AND THEATER

INITIAL DEPLOYMENT AND ASSIGNMENT OF FOLLOW-ON UNITS

- Combat units are assigned to particular areas of the battlefield by one of two principal options with a number of suboptions:
  - (1) Direct assignment of each unit to a particular area by the user
  - (2) Assignment of each unit to an area by unit-control logic internal to the program
- There are two assignment phases that must be understood for both primary options
  - -- The initial deployment of forces to represent the combat situation on the first day of hostilities
    - A user specifies all unit locations
    - Units are in either active or in inactive battle areas throughout the theater
    - In a sense, the initial deployment of forces is always a direct assignment by the user
  - -- The assignment of units arriving in a theater at some time after the first day
    - Assignment may be either direct or determined from logic internal to the program
    - Units arriving in a theater may be directly assigned to one of the following locations
      - a. A particular inactive battle area
      - b. A particular sector
      - c. A particular region

TACWAR GROUND AND THEATER

INITIAL DEPLOYMENT AND ASSIGNMENT OF FOLLOW-ON UNITS (Continued)

- In carrying out these direct assignments, it is important to know whether a unit must begin at some theater entry point and move through the theater to its final destination or whether it can enter directly into its final location (as would be the case of air deployment of combat units into battle areas).

- If an arriving unit enters at its final location, a battle area index signifying its destination must be provided as a time-t input.

- If the arriving unit is to move through the theater to its final location, the following steps are required for its proper assignment:

  -- For a unit that has been assigned to a particular inactive battle area, the submodel logic moves the unit to the stated battle area. If the battle area to which this new unit was assigned is overrun by the time the new unit arrives, then the new unit stops at the most forward inactive battle area in the sector and awaits assignment to move into the active battle area.

  -- When an arriving unit is assigned to a particular sector, the control logic will move the unit to the battle area in that sector; the unit then begins its move forward through the sector to the forward inactive battle area of the sector, from which location the unit will be assigned to active combat as the submodel logic dictate.

IDA

TACWAR GROUND AND THEATER

INITIAL DEPLOYMENT AND ASSIGNMENT OF FOLLOW-ON UNITS (Concluded)

- When the control logic assigns an arriving unit to a particular region, it will also assign the unit to a particular sector within the region (the sector chosen depends on the tactical situation within a region at the time and on whether the side is attacking or defending).

- If the side is defending, the control logic will assign the arriving unit to a sector within the region with either the largest effective ground-force ratio against the defender counting all units presently assigned to the sector (whether in active or inactive battle areas)--or with the most advanced FLOT/FEBA location of all sectors under consideration. It is a user option to choose the technique, though the first option is automatically employed if a user does not indicate differently.

- If the side is attacking, the arriving unit will be assigned to a sector within a region where the FLOT/FEBA has achieved maximum advance of all sectors in the region, unless the advance in the sector of main attack is halted by the amount of exposed flank (the arriving unit is assigned to that adjoining sector with minimum FLOT/FEBA advance--in order to shorten the longest exposed flank); or

- The force ratio has fallen below a minimum acceptable value in any sector of the region (if there is more than one such sector, the sector with the smallest force-ratio for the attacker--considering all units in the sector--will receive the arriving unit).

TheaterControl8

IDA

GROUND COMBAT SUBMODEL

REINFORCEMENT OF DEFENSIVE POSITIONS

- There are a number of defensive positions within each sector that indicate positions where a defender will reinforce in an attempt to hold and that an attacker will reinforce in an attempt to penetrate. The defensive positions correspond to either prepared positions, hasty positions, rivers, or other user specified barriers. These positions are at predefined distances from the base point of each sector.

- A defender will attempt to reinforce a particular defensive position with forces sufficient to bring the force-ratio in that sector to a level where an attack stops (i.e., to a "holding force-ratio" level). Where the reinforcing units come from depends on the location in respect to the threatened position.

- Reinforcements will generally come from the inactive battle areas immediately to the rear of active battle areas. For example, if enemy forces can reach a defensive position by the end of cycle n+1 with a rate of movement sustained in cycle n, then the defensive force will consider moving units into the active battle area for defense of that position during cycle n+1 (provided there is frontage space available for the units). However, combat units in an adjacent sector may be used to reinforce another sector if the situation dictates and the user has set up time-t reinforcements. The model does not automatically look at adjacent sectors for reinforcements.

- If there are one or more combat units in the battle area immediately to the rear of an active battle area, these units will be considered as reinforcement units. The order which the model selects the units to be reinforcements in the following manner:

GROUND COMBAT SUBMODEL

REINFORCEMENT OF DEFENSIVE POSITIONS (Continued)

-- Determine the current effective combat value (considering current personnel, weapons, and supply levels) for all units in the inactive battle area bordering the active battle area.

-- Order each of the units located there by their effective combat value (from largest to smallest).

-- Select as a reinforcing unit the largest-valued unit expected to be assigned to the active battle area. If the addition of this unit is not sufficient to bring the force-ratio to an acceptable level for this position, assign the unit with the next largest combat value to the active battle area. For reinforcement of a given battle area, consideration must be given to the width of the battle area and the frontage of all the units deployed in the area. If there is insufficient room for an additional unit when all units are deployed on a minimum frontage, then the logic does not permit the desired reinforcement.

-- Check for location tag. Some units can fight in only one sector or one region because the user has identified them with a tag or ID that either prevents them from being reassigned to other sectors as needed or puts them low on a priority list of reassignable units.

Reinforce2

REINFORCEMENT OF DEFENSIVE POSITIONS (Concluded)

The logic described above has been oriented to the defender viewpoint. The attacker will react in a similar fashion when encountering a prepared defensive position in an active battle area. For example, if an attacker encounters a prepared position during a cycle, and if the present *force-ratio in the occupied terrain does not* permit a penetration of the prepared position during this cycle, then the attacker must stop the attack and reinforce the sector with available forces until the attack has attained a force-ratio sufficient to attack a prepared position. The attack begins upon attainment of the desired force-ratio.

- These requirements can cause several alternative situations:
  - -- It may be that because of the limit on the number of combat units the attacker can commit to the attack in this sector (based on combat unit frontages and sector width), the required force-ratio cannot be obtained. In this case, a force-ratio cannot be obtained. Therefore, the force-ratio attained from the maximum number of combat units deployed will be the force ratio in effect for the attacking side.
  - -- It may be that the number of combat units available to commit to an attack is not sufficient to achieve a required force-ratio. In this case, the attacker must assume a holding posture to await further reinforcements. If after reinforcement the attacking force attains the required force ratio, then the attack will take place.
  - -- In all other respects, the attacker's choice of units to be used as reinforcements, as well as where they are selected, follows the logic for the defending side.

GROUND COMBAT SUBMODEL

CALCULATION OF COMBAT UNITS PER SECTOR

- The procedure for reinforcing battle areas with particular combat units is as follows:
  - First, determine the number of combat units of a given type that, on the basis of the minimum width (for a specific mission and combat deployment), will fit online in the active battle area of a particular sector.
  - Since there may be multiple types of combat units already in the active battle area, it is necessary to determine the number of additional combat units that can fit.
- The submodel first selects the combat unit with the largest effective combat value.
- If this combat unit cannot enter the sector because its minimum width is too large for the remaining area, then the model tries the combat unit with the next largest effective combat value.
- This process continues until either the active battle area is filled or all combat units available as reinforcements have been tested.
- If none of the combat units examined can enter into the active battle area, then there are no reinforcements for this period.
- Any combat unit that is added to the active battle area moves in on the right flank of the Blue combat units already there (and the left flank for Red combat units)--with their relative locations being adjusted accordingly.
- As each combat unit fights, takes casualties, and finally becomes ineffective, the logic pulls them out of the active battle area and replaces them with a more effective unit.
- This replacement unit does not move into the space just vacated, however, instead it enters into the active battle area to the right or left flank of existing combat units.

Calculations1

GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS

- Conventional, nuclear, and chemical combat within the TACWAR model gives rise to losses of personnel and weapons within specific combat units. Moreover, nuclear weapons fired at particular subunits of combat units are capable of destroying the entire subunit with one blow.

- As each combat unit loses personnel or weapons strength, combat effectiveness goes down to a point where it must be replaced with a more effective unit. The theater-control routines contain options that allow a user to choose one of the following methods for handling replacements within combat-size units:

  -- One method, referred to as the individual-replacement method, uses personnel, weapons, and (for this submodel) subunits as replacement resources for those combat units in need of replacement.

  -- The second replacement method, referred to as "the unit-replacement method," does not permit replacements to enter a combat unit while it is in active combat. When the combat unit effectiveness drops to a predetermined level, the logic withdraws the combat unit from combat and replaces it with a unit of higher effectiveness.

  -- The third replacement option is a combination of the two previous methods, as determined by the user input commands.

GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS (Continued)

- Replacing conventional combat losses
  - The conventional ground combat submodel, using both ground- and air-delivered munitions, generates on a unit-by-unit basis the number of personnel and weapons destroyed each period. Built into the model is a replacement pool that contains personnel and weapons to replenish combat units located in the active and inactive battle areas.
  - Replacements go to the active battle area first and then to combat units in inactive battle areas. If the replacement pool has sufficient personnel to satisfy all replacement demands, nothing else need be done. However, if the demand for combat units in active battle areas exceeds personnel available, then each unit receives replacement in proportion to its demand. Weapons replacement procedures follow the same logic as personnel replacements--but on a weapon-by-weapon basis. Replacements will build a unit back to TOE strength for personnel and weapons, but will not exceed that strength.
  - The model does not explicitly model the movement of the replacements from the replacement pools to the receiving units. Rather, it assumes that replacements--if they are available--will make it to their needy units as required.

IDA

GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS (Continued)

- Replacing nuclear and chemical combat losses

  - Nuclear and chemical weapons have the potential of not only causing personnel and weapon losses, but also of destroying whole subunits. In addition, each nuclear or chemical weapon fired into a zone of a combat unit has a bonus effect on other subunits in the zone. The model averages the bonus effect of a given nuclear or chemical weapon over all subunits in a zone less those subunits that were targeted separately. (The nuclear and chemical submodel discussion above further describes the bonus effect calculations.)

  - As additional weapons detonate in a given zone, damage to individual subunits increases until it reaches a level where *all subunits of a given type could be* destroyed.

  - An ineffectiveness level, established by the user, represents the personnel losses that a subunit can endure before it must be withdrawn from combat and replaced. Thus, subunits in a zone that exceed their ineffectiveness level must be withdrawn. The model determines the number of subunits that are ineffective each period and must be removed from the combat unit. It was noted earlier that combat units may lose personnel, weapons, and subunits in one of three ways:

    (1) Attrition of personnel and weapons by conventional combat

    (2) Subunits being destroyed outright by nuclear weapons

    (3) Subunits being worn down to an ineffective level by numerous nuclear and chemical weapons.

IDA

GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS (Continued)

- The individual personnel and weapons in the replacement pool go to combat units, on the basis of the calculated demand for replacements. The demand for replacements of both people and weapons in individual combat units is a function of--
  - Number, per TOE, of the same type of subunits in combat unit
  - Number of combat units in a sector
  - Number of subunits, by type, that would be in a sector if all combat units were at full TOE strength.
- The total number of subunits by type actually in a sector.
- After the demand for combat unit subunits has been considered, the process of bringing the entire combat unit up to TOE personnel and weapons strength generates a demand based on the following:
  - The TOE personnel strength of a combat unit.
  - The current personnel strength of a combat unit in a sector during a time period.
  - The TOE number of weapons by type in a combat unit.
  - The current number of weapons in a combat unit in a sector during a certain time period.

Calculations5

IDA

GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS (Continued)

-- A basic factor in building subunits out of individuals and weapons is that each subunit has defined for it a major weapon type (e.g., a tank is a major weapon for an armor company). The model aggregates major weapon types until it has enough to form a subunit. If a subunit has no major weapon specified, then the logic assumes it is predominantly people.

- Satisfying replacement demands

  -- Replacement demands may be satisfied by using a subunit-replacement policy, an individual-replacement policy, or some combination of the two. The policies to be followed are discussed below in the order they are implemented: subunit *replacements*, followed by individual replacements.

- Subunit replacements

  -- The model currently uses the pool of personnel and weapon replacements to build new subunits. New subunits are created in two steps: First, the model makes new units by combining the criteria to form a new unit as a function of:

    - TOE personnel strength of a particular type.
    - The number of people in the replacement pool at a particular time.
    - The number of personnel required from the replacement pool to make a certain number of subunits.
    - The number of new subunits that can be formed by personnel from the replacement pool on the basis of unit demand.

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GROUND COMBAT SUBMODEL

CALCULATION OF REPLACEMENTS (Concluded)

-- Then, the model makes other new subunits by grouping the major types in the replacement pool according to the following criteria:

- The major weapon type for each subunit.
- The TOE number of major weapons in a subunit.
- The number of a particular major weapon in the replacement pool at a certain time.
- The number of the major weapons required from the replacement pool to make the subunits.
- The number of subunits that can be formed by the particular major weapon types from the replacement pool (on the basis of unit demand).

-- The actual number of subunits that can be formed from available people and weapons is determined by picking the minimum number of units formed from people alone and from weapons alone.

-- These newly formed subunits are allocated to sectors and combat units in proportion to the demand of each combat unit by sector.

• Individual Replacements

-- By updating the data base, the model knows the number of personnel and weapons that are in the replacement pool at any time. Working on an individual basis, the model uses these personnel and weapons to bring under-manned or under-equipped combat units as near to TOE levels as possible. The replacement process is handled separately for personnel and weapons, with both being assigned to combat units, in sectors, in proportion to the demand of each combat unit.

IDA

GROUND COMBAT SUBMODEL

WEAPON REPAIR OPERATIONS

- In each combat engagement, many weapons are damaged, destroyed, or constrained. The actual number of weapons in these categories comes from the weapon attrition due to conventional, nuclear, and chemical firepower. However, a certain percentage of the damaged weapons are repairable (provided that they are recovered).

- For certain missions, like delay and withdrawal, the number of weapons that are not repairable is greatly increased because of the number of weapons abandoned. In the ground combat submodel, the percentage of weapons that are recoverable is made a function of both the tactical mission for each side and the weapon type.

- In addition to weapons damaged because of combat engagements, there is a certain number of noncombat losses each day resulting from breakdowns, accidents, and wearout. The magnitude of these noncombat losses is assumed to be a fixed percentage (by weapon type and tactical mission) of the actual number of weapons in the unit. At present, noncombat losses are assumed to be repairable.

- The number of weapons that on a given day are repairable is a function of the following:

  - The number of weapons on a tactical mission that were damaged as a result of conventional fire power.

  - The percentage of weapons on mission that are abandoned and, hence, unrecoverable.

  - The percentage of weapons that were damaged and are assumed repairable.

Calculations8

WEAPON REPAIR OPERATIONS (Concluded)

- Repairable weapons damaged from conventional firepower get fixed in the repair pool.
- The procedure for repairing weapons damaged by nuclear blasts is more involved than just discussed. Nuclear attack damages weapons in two ways, severe and moderate. The number of weapons in each category is a function of the vulnerability of each weapon type and the yield of nuclear weapons employed. Weapons with only moderate damage are repairable, while weapons with severe damage are destroyed. Thus, the weapons on a mission that received moderate damage from nuclear weapons are sent to the *repair pool for eventual repair.*
- Once in the repair pool, each weapon type has a certain probability of being repaired in a given length of time. The number of weapons that are repaired and moved into the replacement pool each cycle is based on a user-input percentage, provided the maximum output capacity of the repair pool is not exceeded. The maximum daily output of the repair pool in terms of repaired weapons is also specified by the user.

APPENDIX A

TACWAR Information

TABLE OF CONTENTS

1. Abbreviated List of Current TACWAR Users
2. Requirements for TACWAR Operational Capability Hardware and Software
3. Additional References Regarding Rates of Advance
4. Additional References Regarding Casualty Losses
5. Assorted Related Ground Combat Documents

IDA

ABBREVIATED LIST OF CURRENT TACWAR USERS

- OJCS
  - Military Net Assessment (MNA)
  - Excursions from MNA
  - Total Force Capability Assessment (TFCA)
  - Conventional Force Reduction Negotiations
  - Joint Program Assessment Memorandum (JPAM)
  - Joint Strategic Capabilities Plan
  - Chemical Warfare Studies
- USCENTCOM - Force planning and programming
- OAG Korea - OPLAN development
- J55 USCINPAC - studies
- Shape Technical Centre - Conventional Force Reduction Negotiations
- Joint Chemical Warfare Joint Task Force - studied chemical warfare tactics and doctrine
- USEUCOM - Force planning and programming

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REQUIREMENTS FOR TACWAR OPERATIONAL CAPABILITY HARDWARE AND SOFTWARE

- VAX or Microvax
- DEC Fortran 5.1
- ISSCO (Tell-a-Graf, DISSPLA, Data Connection)
- Disk Space Requirements
  - -- TACWAR
  - -- Post-Processor
  - -- Graphics
  - -- Total disk space required - 76.8 megabytes or ~ 150,000 blocks
- Graphic output terminal
- Graphics printer supported by ISSCO
- Personnel - 3 (1 programmer, 2 analysts)
- Start-up training
  - -- TACWAR -- 2-3 weeks
  - -- Post-processor -- 1-2 days
  - -- Graphics -- 1-2 days
- Time to operational capability
  - -- Without support -- 6-9 months
  - -- With on-site support -- 6-7 weeks
- Documentation/data base - provided by J-8/IDA
- PC Capability

Hard&Software

IDA

ADDITIONAL REFERENCES REGARDING RATES OF ADVANCE

1. The movement curves used i.. IDA's TACWAR model
2. The movement from *Numbers, Predictions and War: HERO's Data Base*, Col (Ref) T.N. Dupuy (Movement and Casualties)
3. *Major Front Movements and the Role of Armored Forces*, by Leonard Wainstein
4. *NATO Combat Capabilities Study, Volume VI--Rates of Advance of Theater Forces (Task 7)*, by L.J. Dondero, D.W. Mader, and R.G. Stockton
5. *Rates of Advance in Infantry Division Attacks in the Normandy-Northern France and Siegfried Line Campaigns*, by Leonard Wainstein
6. *Rates of Advance in Land Attack Against Unprepared Forces*, by Marshall Andrews
7. *An Examination of the Parsons and Hulse Papers on Rates of Advance*, by Leonard Wainstein
8. *Military Strategy and Tactics, Computer Modeling of Land War Problems*, Prediction of Advances in Ground Combat," by J.K. Cockrell

IDA

ADDITONAL REFERENCES REGARDING CASUALTIES

1. Force ratio versus casualties as used in IDA's TACWAR model
2. Headquarters, Department of the Army *Staff Officers' Field Manual, Organization, Technical and Logistic Data*
3. *NATO Combat Capabilities Study, Volume IV--Impact of Losses and Replacements on Unit Combat Capability (Task 5)*, by Edward P. Kerlin
4. *Some Allied and German Casualty Rates in the European Theater of Operations*, by Leonard Wainstein
5. *Casualty Rates and Opposed Advance*, by Edward S. Pearsall
6. *Conventional Warfare Damage and Casualty Trends*, by W.C. Yengst and T.G. Smolin
7. *Military Strategy and Tactics, Computer Modeling of Land War Problems*, "Predictive Equations for Opposed Movement and Casualty Rates for Land Forces," by R. Goad

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ASSORTED RELATED GROUND COMBAT DOCUMENTS

1. *The Calculus of Conventional War: Dynamic Analysis Without Lanchester Theory*, by Joshua M. Epstein

2. AD Number B086797L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume I, Main Report, Selected Battles 1600-1973*, September 1984

3. AD Number B087718L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume II, Wars from 1600-1800, Part 1, Wars of the 17th, 18th, and 19th Centuries*, June 1983.

4. AD Number B087719L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume III, Wars from 1805-1900, Part 1, Wars of the 17th, 18th, and 19 Centuries*, June 1983.

5. AD Number B087720L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume IV, Wars from 1904-1940, Part 2, Wars of the 20th Century*, June 1983.

6. AD Number B087721L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume V, World War II, 1939-1945, Campaigns in North Africa, Italy, and Western Europe, Part 2, Wars of the 20th Century*, June 1983.

7. AD Number B087722L, *Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, Volume VI, World War II, 1939-1945, Campaigns in France, 1940, on the Eastern Front, and of the War Against Japan; the 1967, 1968, and 1973 Arab-Israeli Wars, Part 2, Wars from 1904-1940, Part 2, Wars of the 20th Century*, June 1983.

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ASSORTED RELATED GROUND COMBAT DOCUMENTS (CONTINUED)

8. The U.S. Army Concepts Analysis Agency (CAA) published a Combat History Analysis Study Effort (CHASE) series of reports in 1986. This series includes:

   (1) AD Number 175712, *Combat History Analysis Study Effort (CHASE), Data Enhancement Study (CDES), Volume I, Introductory Materials and Bibliography*, 31 January 1986

   (2) AD Number 179734, *Combat History Analysis Study Effort (CHASE), Progress Report for the Period August 1984-June 1985,* August 1986

   (3) AD Number 175714, *Combat History Analysis Study Effort (CHASE), Data Enhancement Study (CDES), Volume III, Tasks 2 and 3*, 31 January 1986

   (4) AD Number 175715, *Combat History Analysis Study Effort (CHASE), Data Enhancement Study (CDES), Volume IV, Tasks 4 and 5*, 31 January 1986

9. *The IDA Tactical Warfare Model: A Theater-Level Model of Conventional, Nuclear and Chemical Warfare* (U), IDA Report R-211, Volumes I and II, October 1985; Volume III, Parts I and II, November 1979; Institute for Defense Analyses, Arlington, Virginia, UNCLASSIFIED.

10. *Institute for Defense Analyses Tactical Warfare (TACWAR) Model--Program Maintenance Manual* (U), Computer Systems Manual (CSM) MM 237-77, Parts I-III, Command and Control Technical Center, Washington, D.C., 6 September 1977, UNCLASSIFIED.

11. *Nuclear Weapon Effects Calculations in the TACWAR Code* (U), SSS-CR-79-3810, Systems, Science and Software, Alexandria, Virginia (draft final), 20 October 1978, UNCLASSIFIED.

ASSORTED RELATED GROUND COMBAT DOCUMENTS (CONTINUED)

12. *Documentation of the IDA Tactical Air Model (IDATAM) Computer Program* (U), IDA Paper P-1409, Institute for Defense Analyses, Arlington, Virginia, February 1979, UNCLASSIFIED.

13. *Improvements to the Nuclear Module of the TACWAR Code* (U), SS-CR-80-4242, Systems, Science and Software, Alexandria, Virginia, 30 November 1979, CONFIDENTIAL.

14. *TACWAR Inputs/Outputs* (U), Technical Memorandum TM 226-80, Volumes I and II, Command and Control Technical Center, Washington, D.C., 15 February 1980, UNCLASSIFIED.

15. *A Detailed Review of the TACWAR Model* (U), HDL-TM-80-154, Harry Diamond Laboratories, Adelphi, Maryland, December 1980, UNCLASSIFIED.

16. *Modifications to the IDA Tactical Warfare Model TACWAR* (U), IDA Paper P-1535, Institute for Defense Analyses, Alexandria, Virginia, March 1981, UNCLASSIFIED.

17. *C3 Modified TACWAR Model* (U), HDL-TR-181, Harry Diamond Laboratories, Adelphi, Maryland, May 1981, UNCLASSIFIED.

18. Volume I, Military Operations Research Series of Monographs and Texts Sponsored by Military Operations Research Society (MORS), *Military Applications of Modeling: Selected Case Studies, Chapter 6, A Theater-Level Model-IDA TACWAR*, 1981, UNCLASSIFIED.

19. *Development of a Data Base for the Chemical Warfare Study* (U), S-489, Institute for Defense Analyses, Alexandria, Virginia, July 1979, SECRET/RESTRICTED DATA.

ASSORTED RELATED GROUND COMBAT DOCUMENTS (CONTINUED)

20. *A Study of Chemical Warfare in Central Europe* (U), IDA Study S-505, Institute for Defense Analyses, Alexandria, Virginia, July 1980, SECRET.

21. *Nuclear Escalation and Targeting Options* (U), IDA Study S-528, Institute for Defense Analyses, December 1981, SECRET/RESTRICTED DATA.

22. *Chemical Warfare in Central Europe, Circa 1986* (U), IDA Study S-518, Institute for Defense Analyses, Alexandria, Virginia, December 1981, SECRET/RESTRICTED DATA.

23. *Theater Integrated Warfare Scenario Evaluation Studies* (U), IDA Paper P-1636, Institute for Defense Analyses, Alexandria, Virginia, May 1983, SECRET/RESTRICTED DATA.

24. *Cost-Effective Analysis of Airbase Attack Weapons in a Chemical Environment* (U), IDA Paper P-1717, Institute for Defense Analyses, Alexandria, Virginia, July 1983, SECRET.

25. Volume I, Military Operations Research Series of Monographs and Texts Sponsored by Military Operations Research Society (MORS), *Military Applications of Modeling: Selected Case Studies, Chapter 6, A Theater-Level Model-IDA TACWAR*, 1981, UNCLASSIFIED.

26. *Decision Modeling in Large Scale Conflict Simulations* (U), IDA Paper P-1355, Institute for Defense Analyses, Alexandria, Virginia, 1978, UNCLASSIFIED.

27. *Combat Processes and Mathematical Models of Attrition* (U), IDA Paper P-1081, Institute for Defense Analyses, Alexandria, Virginia, UNCLASSIFIED.

APPENDIX B

GROUND COMBAT SUBMODEL SUPPLEMENT

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

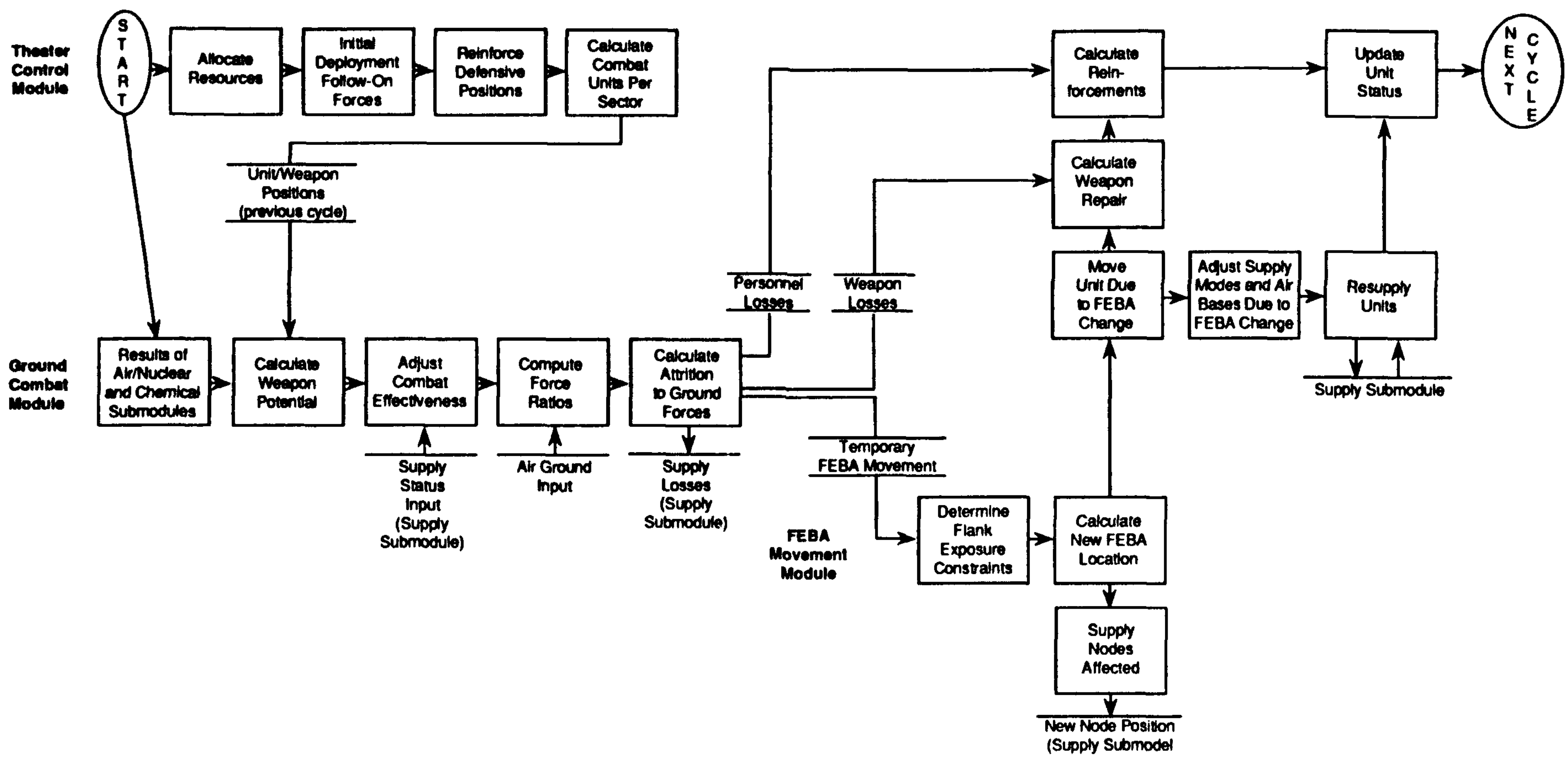
- The next several charts contain additional description of the ground submodel in terms of the following concepts:
  - (1) Linkage of the ground submodel to other submodels
  - (2) Resources considered by the ground submodel
  - (3) Types of tactical situations
  - (4) Parameters of unit effectiveness
  - (5) Attrition calculations by use of the force-ratio concept for determining casualties and weapon losses
  - (6) FLOT/FEBA movement and constraints to movement
  - (7) A summary description of the theater control routines as they pertain to the ground submodel

The ground combat submodel (or module) links with other submodules of the model. The air submodel (with or without chemical and nuclear) is called from the main TACWAR program first followed by theater control, ground, FLOT/FEBA movement, supply, etc.

The flow diagram illustrates a flow of calculations that take place in submodules that are most closely related to the ground combat submodel. Model variables are calculated and updated each cycle as the combat action is modeled.

Results from previous cycles are used and considered during the calculation of the active cycle. By using input variables and dynamically calculated variables, things like FLOT/FEBA movement are determined by the submodules.

SUBMODEL FLOW DIAGRAM



SubmodelFlowDiag

SUBMODEL LINKAGE

A. Theater Control Submodule

This submodule controls the allocation of resources to the theater of operations being simulated by the TACWAR model. Initial deployment of follow-on forces and the reinforcement of defensive positions are considered in the calculation of the combat units modeled per sector.

B. Ground Combat Submodule

Most of the remainder of this document will colaborate on many of the actions modeled in the ground combat submodule linkage. The flow diagrams illustrate the dependency of combat actions on supplies.

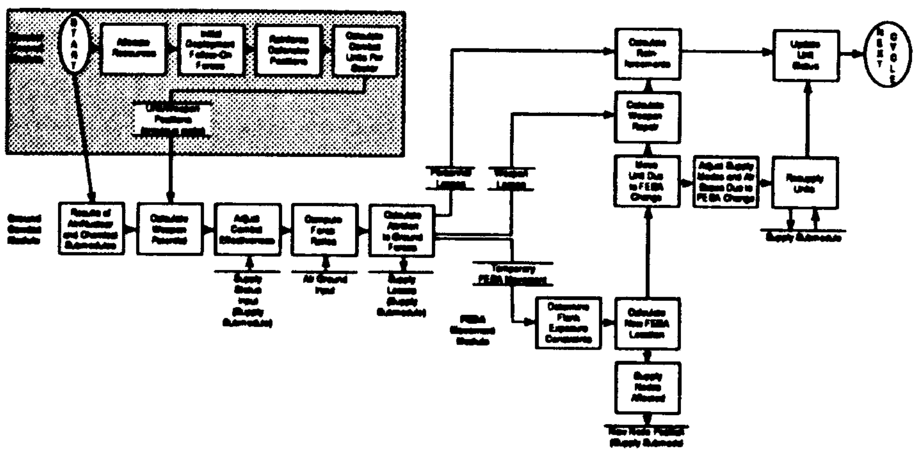
C. Unit Status Adjustments

Unit status adjustments are accomplished by a number of subroutines in the model. The dynamic adjustments of each cycle are used alone with input values to determine the flow of ground combat.

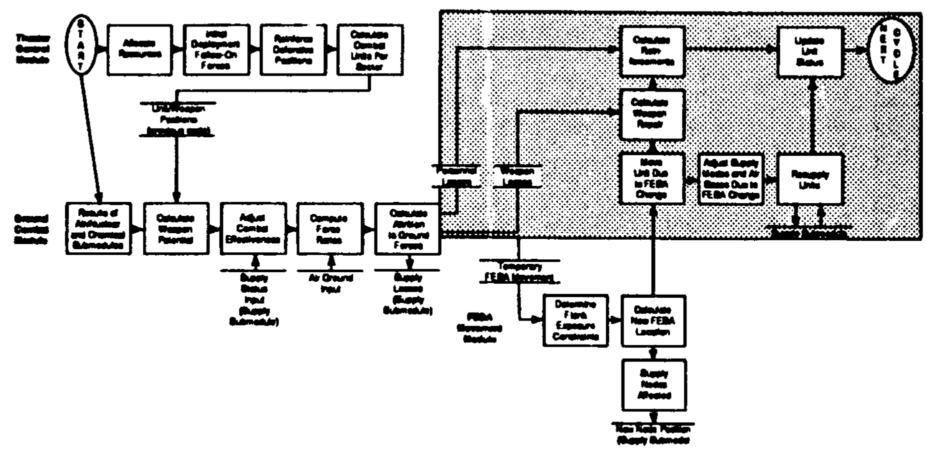
D. FLOT/FEBA Movement Submodule

The cycle-by-cycle location of the FLOT/FEBA is calculated and adjusted by this section of the model. Input flank exposure constraints may be considered or ignored under the control of the user of the model.

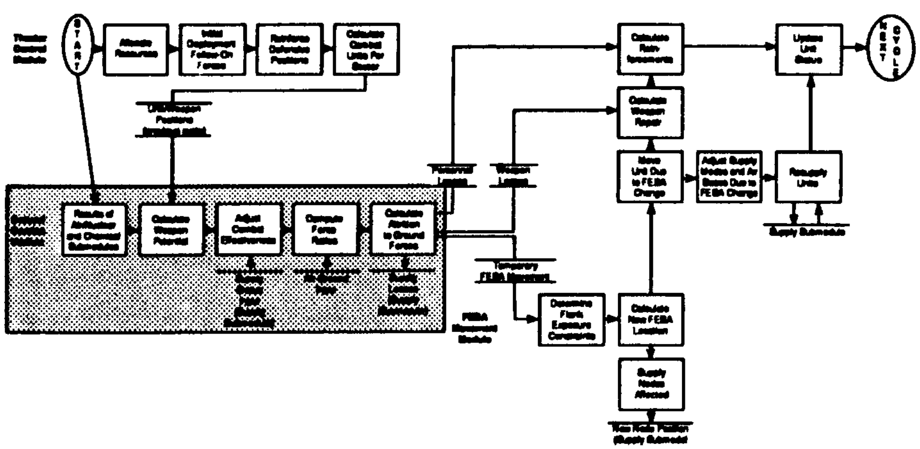
SUBMODEL LINKAGE DIAGRAM



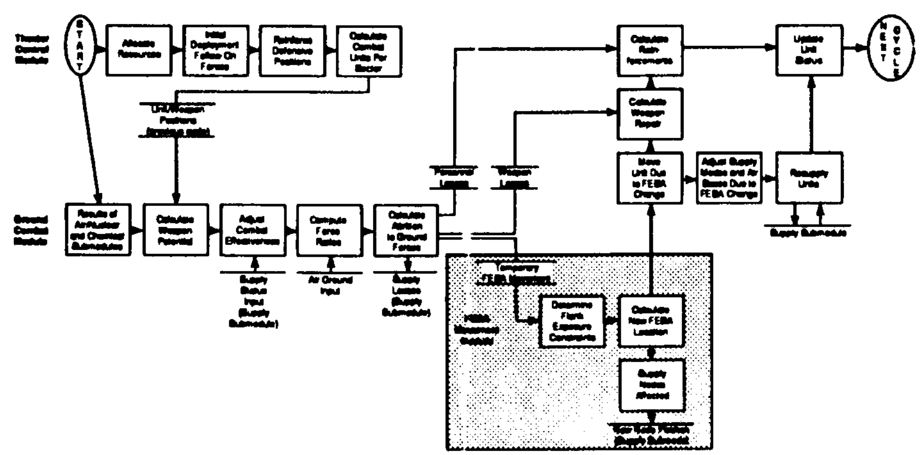
A. Theater Control Submodule



C. Unit Status Adjustments



B. Ground Combat Submodule



D. FLOT/FEBA Movement Schedule

GROUND SUBMODEL RESOURCES CONSIDERATIONS

Several key resource considerations include:

- Combat Units
- Weapons
- Supplies
- Mines

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

RESOURCES CONSIDERED BY THE GROUND SUBMODEL

- The two opposing sides in the TACWAR model (denoted by Red and Blue) are structured in a symmetrical manner; however, they may have different force levels and may have different combat rules.

- Each side's general forces can have various resources--with certain of the resources having either a single conventional, nuclear, or chemical capability or multiple capabilities. The resources include:

    A. Combat Units

    B. Weapons

    C. Supplies

    D. Consideration of Mines

Resources1

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

COMBAT UNITS

- Units are aggregated based on certain functional characteristics to simplify processing.

- The characteristics considered for combat units include:

  -- Type of combat unit
  -- Number of people, by combat unit type according to full TOE authorization
  -- Number of weapons, by combat unit type and notionalized weapon type according to full TOE authorization
  -- Effectiveness value of combat unit type assuming the unit is at full TOE strength
  -- Current number of people for each combat unit
  -- Current effectiveness value of each combat unit
  -- The unit effectiveness when entering into combat
  -- Standard combat unit frontage which depends on the unit tactical posture and combat deployment (tactical postures are attack/delay, attack/defense of prepared area, and attack/defense of hastily prepared area; combat deployments are non-nuclear, nuclear prepared, and nuclear)
  -- Maximum expansion factor for combat unit frontage

Resources2

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

COMBAT UNITS (Continued)

- Characteristics (concluded)
  - -- Minimum contraction factor for combat unit frontage for Red and Blue
  - -- Unit depth factor based on frontage
  - -- Supply consumption (in tons per cycle), by combat unit, posture, and supply class
  - -- Planned supply consumption (in tons per cycle), by combat unit type, and supply class
  - -- TOE number and distribution (by zone and combat unit type) of combat unit subunits
  - -- Current number and distribution (by zone for each combat unit) of combat subunits
  - -- Radius of each subunit as deployed by zone and in reserve
  - -- TOE levels of personnel and major weapons, by type, in each subunit type and for each combat unit type
  - -- Current level of personnel and major weapons, by subunit type for each combat unit
  - -- Number of ground sensors by type in a zone for a notional combat unit with full TOE allowances (this number varies via a multiplying factor for each type of combat unit)
  - -- Number of Army air vehicles equipped with target acquisition sensors used for target acquisition purposes, according to TOE allowances.

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

WEAPONS

- The number and type of weapons to be played for either side is a user input.

- Various arrangements of weapon types are possible; however, the following weapon types (considered to be significant in their contribution to Theater-level firepower) are usually included:

  -- Tanks
  -- Infantry Fighting Vehicles (IFVs)
  -- Armored Personnel Carriers (APCs)
  -- Antitank Weapons (light or short range)
  -- Antitank Weapons (heavy or long range)
  -- Mortar
  -- Medium to Heavy Artillery
  -- Missiles and Rockets
  -- Helicopters
  -- Air Defense Artillery (ADA)
  -- Surface-to-Air Missile Systems (SAMs)

Resources4

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

WEAPONS (Continued)

- Only weapons organic to combat units are identified here.
- Other noncombat unit weapons (e.g., SSMs, point and area SAMs, and long-range rockets) may be considered by the submodel but are played differently than organic combat unit weapons.
- Weapons are located either in combat units or in weapon-replacement or weapon repair pools.
- When in combat units, the weapons appear wherever the combat unit is located.
- When assigning replacement weapons to a combat unit, the submodel will not exceed the level authorized by the TOE, but a user can attach additional units if more firepower is desired.
- A major replacement pool for personnel and weapons is assumed to be in the COMMZ.
- Weapon repair and minor replacement pools are assumed to exist in the forward most inactive battle area of each sector.
- For each weapon system shown above, the ground model considers the following characteristics:
  - Range
  - Probability of kill
  - Payload.

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

SUPPLIES

- The outcome of the conventional ground combat influences the supply status of both ground and air units.
- The unit of measure for the general classes of supply is short tons (2,000 pounds).
- Supplies in the TACWAR model are considered for several aggregated classes or categories of supply for both ground and air units (these classes or categories of supplies do not include nuclear or chemical warhead replacements, and SSM replacements, which are handled separately.
- Each combat unit and each type of aircraft consumes a certain amount of supplies (short tons) per cycle.
- The consumption rate per combat unit varies by tactical posture and whether or not the unit is at full personnel and weapons TOE strength.
- The consumption rate for aircraft is by sortie.
- Attacks and attrition to units reduces the amount of supplies on hand.
- The ground model passes the supply losses to the supply and Theater control models for adjustment and reinforcement.
- One item to note is that the supply cycle can last up to 72 hours while the combat cycles last only 12 hours. Therefore, the Theater control model stores supply changes for the supply model.

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - RESOURCES CONSIDERED

CONSIDERATION OF MINES

- **Minefields may be considered in the ground combat routine and may be of variable depth and density. In the ground model, the minefields themselves do not cause casualties, rather the presence of a minefield acts as a barrier to delay or canalize the attacker; much like a terrain feature, such as a mountain or stream.**
- **Since minefields are covered by fire, they cause the attacking unit to encounter greater attrition and they degrade the attacking units movement.**
- **Due to the scale of the model, TACWAR minefields can be considered fairly large area minefields.**
- **Point mines and hasty protective minefields are not considered.**

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATION

TYPES OF TACTICAL SITUATIONS

- When conventional weapons are being used on the battlefield, combat follows a strictly conventional-type theater war, with certain combat engagements taking place.
- If, on the other hand, nuclear and chemical weapons are used, certain aspects of warfare (especially the concept of unit dispersion and unit deployment) may change drastically. In the following charts, two military situations are described more thoroughly:

  A. Combat Engagements
  B. Combat Deployments

- As sector attacker moves, the second and third echelon forces will move to maintain the prescribed offsets.
- During engagements where units must be withdrawn from contact, a simulated "passage of lines" effect is modeled.
- In a situation with restrictive terrain, where all of a unit's weapons cannot be brought to bear on the enemy, the number of active firing weapons can be adjusted.
- Checkpoints may be represented as delays to units and as time to clear interdicted checkpoints.
- Point objectives may be assigned to units to move to during combat engagements.

TacSituations1

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT ENGAGEMENTS

- Prior to engaging units in combat, TACWAR considers the unit tactical posture.
- Unit posture depends on the tactical missions of the opposing forces and, where appropriate, on the defensive positions.
- Tactical missions may be defined as follows (for example):
  - -- Attack
  - -- Defend
  - -- Delay.
- Defense positions may be defined as follows (for example):
  - -- Prepared
  - -- Hasty
  - -- Barriers (natural or man-made).
- Delaying positions represent units defending on the move without specific defensive positions.
- A unit tactical posture may influence the weapon's value. For instance, prepared positions can increase ground weapon value more than a hasty defensive position.
- Tactical posture can also influence unit movement and supply use.
- At the very start of the simulation, where time=0, one side is identified as the "Theater attacker" and the other side as the "theater defender."

TacSituations2

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT ENGAGEMENTS (Concluded)

- The breakthrough-movement rate holds for only one cycle. (Movement rates for the breakthrough situation are calculated by multiplying a factor, input by the user, times the movement rates assumed for a delay situation.)
- The model represents barriers as natural or man-made impediments to movement (e.g., major rivers, mountains, or major cities).
- Barriers affect movement and casualties in the same way as prepared positions, except that attackers cannot penetrate a barrier and gain a breakthrough advantage.
- So barriers, in addition to their effects on movement, also have value as defensive positions.
- Barriers impede movement to both sides.
- As previously mentioned, TACWAR models minefields as if they were barriers.

TacSituations3

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT DEPLOYMENTS

- Unit posture has a significant effect upon the outcome of a combat engagement. However, in order to attain the tactical posture, units must deploy.

- Battle units deploy for combat in various ways, most of which are to increase or decrease subunit dispersion and/or battle-unit density of personnel and equipment.

- Since the TACWAR model is designed to play conventional, nuclear, and chemical warfare, three levels of unit dispersion/density can be considered. Characterized by different combat deployments, these levels are:

  -- Non-nuclear
  -- Nuclear prepared
  -- Nuclear.

- For each combat deployment, each unit type (while in an attack or a defense posture) is permitted to adjust its tactical orientation and frontage.

- As a result, six possible deployment-posture situations can arise where unit sizes and densities may be different.

- A user might input, by unit type, the standard frontage in each of these six tactical orientations. In addition, there is an input factor that determines the depth of a unit based on its frontage value.

- Other dimensions that are computed from input factors are the minimum and maximum frontage that each unit can have for each of the tactical orientations. These factors may change for Red and Blue by corps area (i.e., by sector), but not by unit type.

TacSituations4

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT DEPLOYMENTS (Continued)

- Thus, units from each side may be placed on-line in an active battle area in quantities as needed or desired--but not to exceed minimum frontage constraints. With only a few units in an active battle area, the unit deploys at maximum frontage. In this case, the unoccupied land area is assumed to be on the flanks of the deployed units.
- The ground submodel considers the concept of combat deployment in the following ways:
  - -- If the war is a non-nuclear war, then all combat units are considered to be in a non-nuclear deployment (however, a user can change the deployment by input).
  - -- If either side makes a preemptive nuclear strike, the user can adjust the combat deployment of the side making the strike to a nuclear-prepared (or nuclear) deployment (while the side receiving the strike could still be in a non-nuclear deployment).
  - -- If both sides start in a non-nuclear or a nuclear-prepared deployment, the initial use of nuclear weapons may (by user choice) automatically force either side or both sides into nuclear-prepared or nuclear deployment.
  - -- If circumstances arise by which either side or both sides are in a nuclear (or nuclear-prepared) deployment and, for tactical reasons, the sides want to transition to a non-nuclear deployment, rules are available to handle these moves.

TacSituations5

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GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT DEPLOYMENTS (Continued)

- In addition to having a user input all deployment changes, the nuclear and chemical firing doctrine within the nuclear and chemical submodels has been designed to be sensitive to the need for changes in combat deployments. That is, when certain nuclear or chemical escalation levels are reached, internal decision rules may cause a change in unit combat deployment. (A description of the nuclear and chemical escalation state is presented in their respective briefings.)
- Changing unit combat deployment entails a certain time of transition between one deployment posture to another.
- These times are essentially delay times in making the transition.
- Results of various studies have indicated that a transition from a non-nuclear to a nuclear-prepared (or nuclear) deployment can be accomplished under certain favorable conditions; however, adequate planning is considered essential to accomplishing a successful transition
- Conditions considered favorable for a successful change in deployment are an ability to:
  - Disengage forward elements at the appropriate time
  - Execute the change in deployment under cover of darkness
  - Make the change without undue pressure from the enemy.

TacSituations6

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - TACTICAL SITUATIONS

COMBAT DEPLOYMENTS (Concluded)

- Change in unit deployment status may result in high personnel casualties and weapon losses if carried out in the daylight while the force is under heavy pressure.

- A deployment change may require many hours from the time the alert is given to the completion of the transition to a new combat deployment. Time is required for the planning, coordinating, and movement phases.

- Delay time (representing the total time involved in a transition) is the period considered by the ground submodel.

- Transitioning from nuclear deployment to non-nuclear deployment appears to be made easier if, for example, the defending force is able to adjust its position within a battle area. That is, if available reserve elements can move into defensive positions some distance behind the present FLOT/FEBA location, then the front-line combat units making the change in combat deployment can withdraw to the location of the reserve elements and into new non-nuclear defensive positions.

- When transitioning from a nuclear deployment to a non-nuclear deployment, the attacking force may find it easier to go into a temporary holding situation, augment the force in battle with sufficient units to develop a non-nuclear deployment posture, and begin the attack anew.

PARAMETERS OF UNIT EFFECTIVENESS

- Combat effectiveness of a unit is a measure of the unit current combat value relative to a standard (TOE) combat value. The conventional combat value is a function of
  - -- The unit weapons
  - -- Personnel strength
  - -- Supply level.
- When shortages of personnel, weapons, or supplies exist in a unit, the effect is to reduce the combat value--and, hence, reduce combat effectiveness of the unit.
- The general form used to express the combat effectiveness of a Blue unit on *defense in a certain posture is a function of:*
  - -- Current weapons value divided by TOE weapons value
  - -- Current personnel strength divided by TOE personnel strength
  - -- Supply level on-hand with a unit.
- The current ground value of a Blue unit is a function of:
  - -- Value based on actual strength
  - -- Value based on TOE strength.
- The various parameters that affect the above calculations are:
  - -- Value (based on TOE weapons value) of Blue combat unit on defense in a certain posture.
  - -- The number of weapons per TOE in a Blue combat unit.
  - -- Fractional effectiveness of Blue combat unit based on the ratio of current-to-TOE weapons value.

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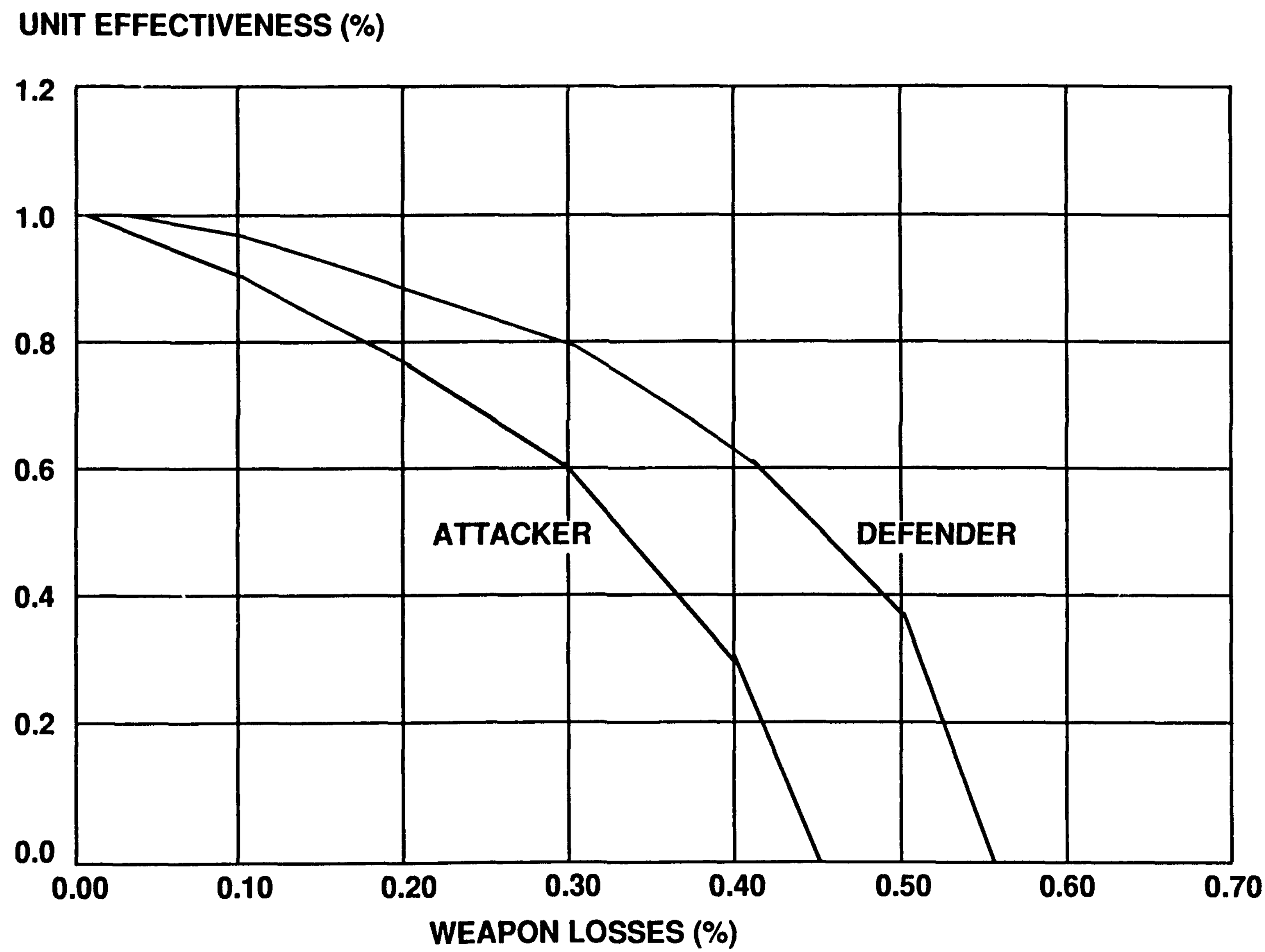
GROUND COMBAT SUBMODEL SUPPLEMENT - UNIT EFFECTIVENESS

- **COMBAT AIR INTERACTIONS NEAR THE FEBA AS CLOSE AIR SUPPORT (CAS) IS CONSIDERED**
  - Examined by region
  - CAS missions
    - ** CAS escort versus battlefield defense aircraft
    - ** CAS SS and CAS versus battlefield defense aircraft
    - ** CAS SS versus SHORADS (in combat units)
    - ** CAS aircraft engaged by SHORADS
    - ** Successful CAS sorties
  - Fly by penetrations fired upon by SHORADS
    - ** Air Battle Area (ABA), INT, and belt SAM suppression
    - ** SHORADS not attacked
  - Belt SAM suppressors engage battlefield defense aircraft
  - Belt SS engage medium range SAMs
  - Escorts (ABA, INT) form a wave and lead against battlefield defense aircraft
  - Attack and SAM suppressors versus battlefield defense aircraft
  - Survivors continue on missions
    - ** Forward
    - ** Rear
    - ** COMMZ

UnitEffec2

ILLUSTRATIVE DIVISION EFFECTIVENESS VERSUS WEAPON LOSSES



DivEffecVsWpnLosses

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - UNIT EFFECTIVENESS

- The various parameters that affect the above calculations are:
  - -- Value (based on TOE weapons value) of Blue combat unit on defense in a certain posture
  - -- The number of weapons per TOE in a Blue combat unit
  - -- Fractional effectiveness of Blue combat unit based on the ratio of current-to-TOE weapons value
  - -- Value (based on weapons value within the unit) of a Blue combat unit in a certain defensive posture against a particular Red force in the battle area
  - -- Fractional effectiveness of a Blue combat unit based on personnel strength
  - -- The effectiveness factor of a Blue combat unit on defense if it were initially at full strength but reduced some fraction of its original strength due to casualties
  - -- Current number of personnel in Blue combat unit
  - -- The TOE number of personnel per TOE in a Blue combat unit
  - -- Fractional effectiveness due to supply shortages for Blue
  - -- Effectiveness factor for supply degradation if Blue has x cycles of supply on hand
  - -- Days of supply on hand for Blue combat unit.
- Similar relationships apply for the combat effectiveness of Red units.
- Supply modeling will be discussed in more detail in the Supply Submodel briefing, but it is significant to mention here in general terms how supply status and consumption impact unit combat effectiveness.

UnitEffec3

IDA

THREE METHODS FOR COMPUTING THE NUMBER OF CASUALTIES AND WEAPON LOSSES

APPROACH A	APPROACH B	APPROACH C
1. Compute actual number of weapons lost by type directly from Lanchester equation.	1. Compute potential number of weapons lost by type.	1. Compute potential number of weapons lost by type.
2. Compute number of casualties by multiplying average casualties per weapon lost by the number of weapons of that *type lost, and summing over* weapon types.	2. Computer number of casualties based on force ratio.	2. Compute total value lost based on force ratio.
	3. Determine actual weapon losses by scaling potential losses so that actual losses times casualties per weapon lost, summed over weapon types, equals number of casualties.	3. Determine actual weapon losses by scaling potential losses so that actual losses times the value per weapon, summed over weapon types equals total value lost.

NOTE: Some models used only one method, such as Approach A. TACWAR considers Approach B and C in its calculations.

ApproachesABC

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GROUND COMBAT SUBMODEL SUPPLEMENT - UNIT EFFECTIVENESS

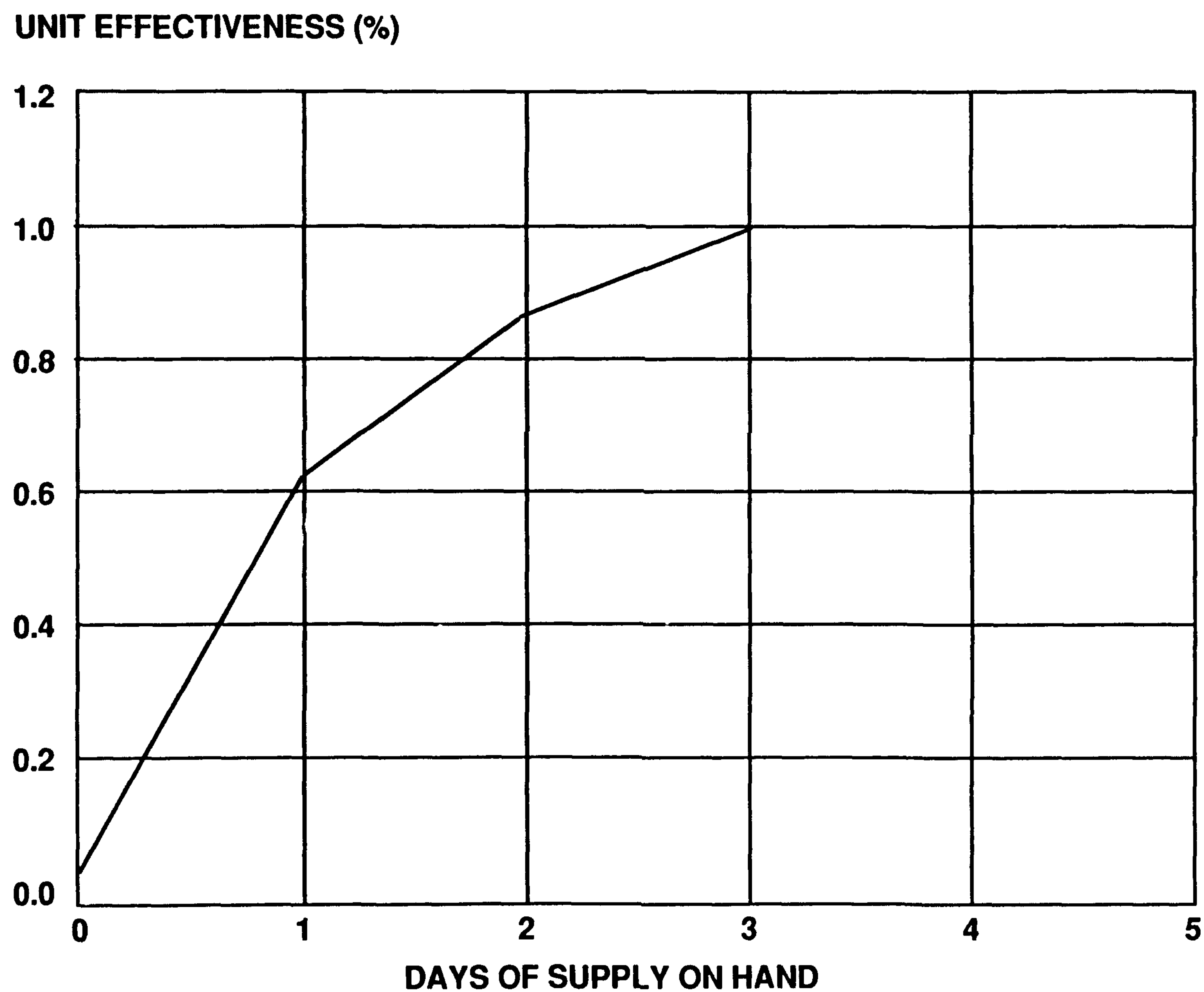
- Obviously, if a unit does not have the supplies it needs, such as ammunition or POL, then its effectiveness will be degraded. Unit effectiveness drops when units have less than three days of supplies on hand. The structure of supply consumption, as applied to one unit, is a function of:
  - -- Planned on-hand supplies (short tons)
  - -- Planned consumption per day by type combat unit
  - -- Number of days of supplies planned for
  - -- Actual on-hand supplies (short tons)
  - -- Days and supplies on hand
  - -- Actual supply consumption on day n
  - -- Demand for resupply on day n (short tons).

- The supply consumption for combat unit is reduced if the number of personnel or weapons is less than the TOE level. The actual consumption is a function of:
  - -- Planned consumption of a combat unit in a particular defensive posture.
  - -- Current effectiveness level of a combat unit (while this might sound like circular logic, it is not--unit effectiveness impacts supply consumption, while supplies available can impact unit effectiveness).
  - -- Planned consumption of a combat unit in reserve posture.
  - -- Modifying factor to account for a unit shortage in personnel or weapons.

- While it is possible to employ different unit effectiveness curves for Blue and Red, it is more common to use the same functional forms for both. It should be noted that this symmetry might not hold because, unlike Blue commanders, Red commanders might hold a unit on the line until it reached a very low level of effectiveness. In this regard, an important distinction would have to be made between the objective capabilities of the units and a commander's perception of the unit capabilities.

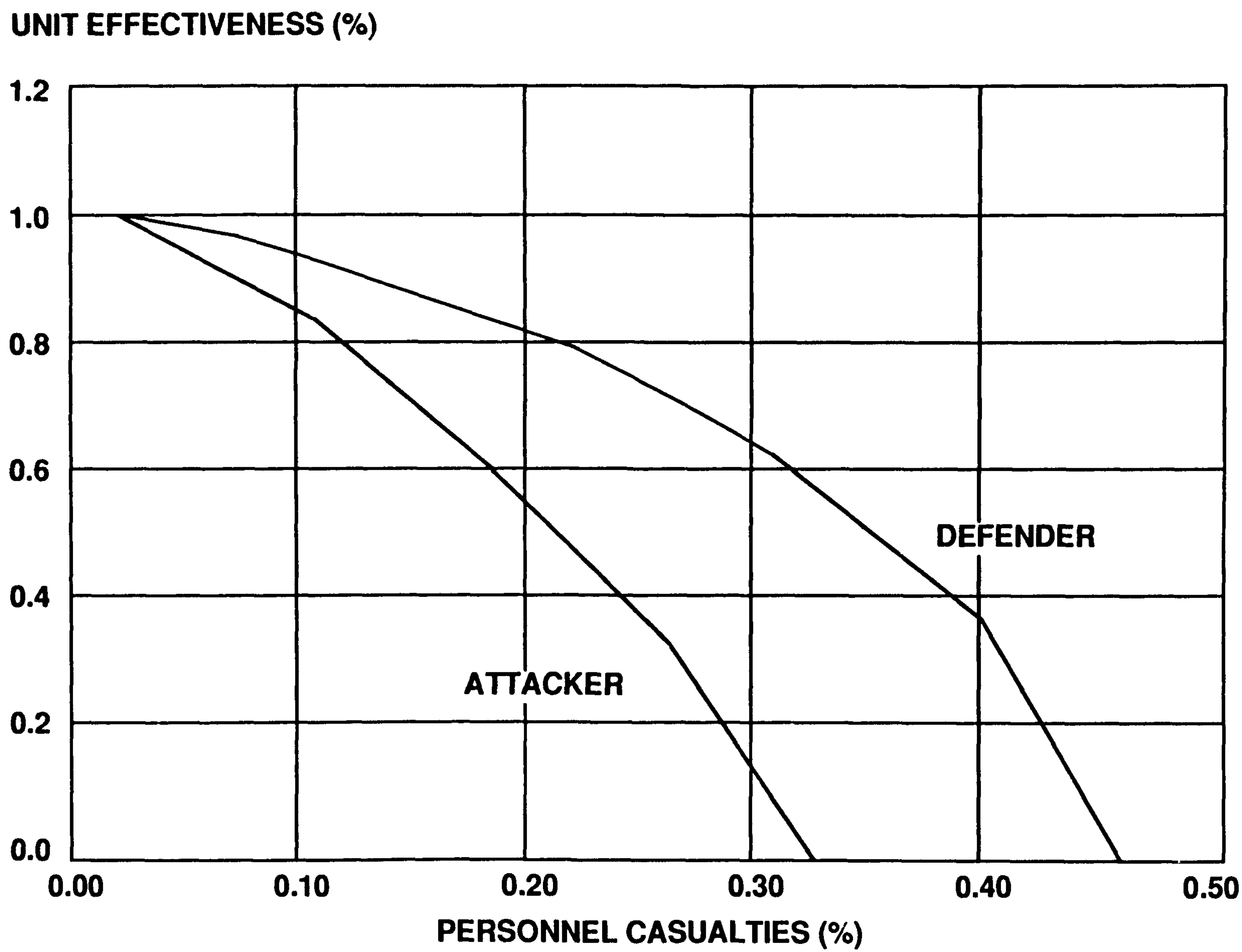
UnitEffec4

ILLUSTRATIVE DIVISION EFFECTIVENESS VERSUS SUPPLY ON-HAND



DivEffecVsSupply...

ILLUSTRATIVE DIVISION EFFECTIVENESS VERSUS PERSONNEL CASUALTIES



DivEffecVsPersCas

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GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

INTRODUCTION

- The ground submodel considers each combat sector in turn, repeating the computations of ground force attrition and FLOT/FEBA movement until all sectors have been examined.
- The ground submodel computes the percentages of opposing ground weapons killed by each side. (This is accomplished by using the standard allocations previously computed to calculate adjusted allocations for both sides ground weapons when Red is on attack.)
- That value and the values of an individual ground weapon against an opponent's ground weapon are used to determine the percentages of each type weapon destroyed.
- The percentages of air kills to opposing ground weapons is similarly computed using the allocation and value of each side's air munitions against the ground weapons of its opponent.
- The following subsections will be discussed:

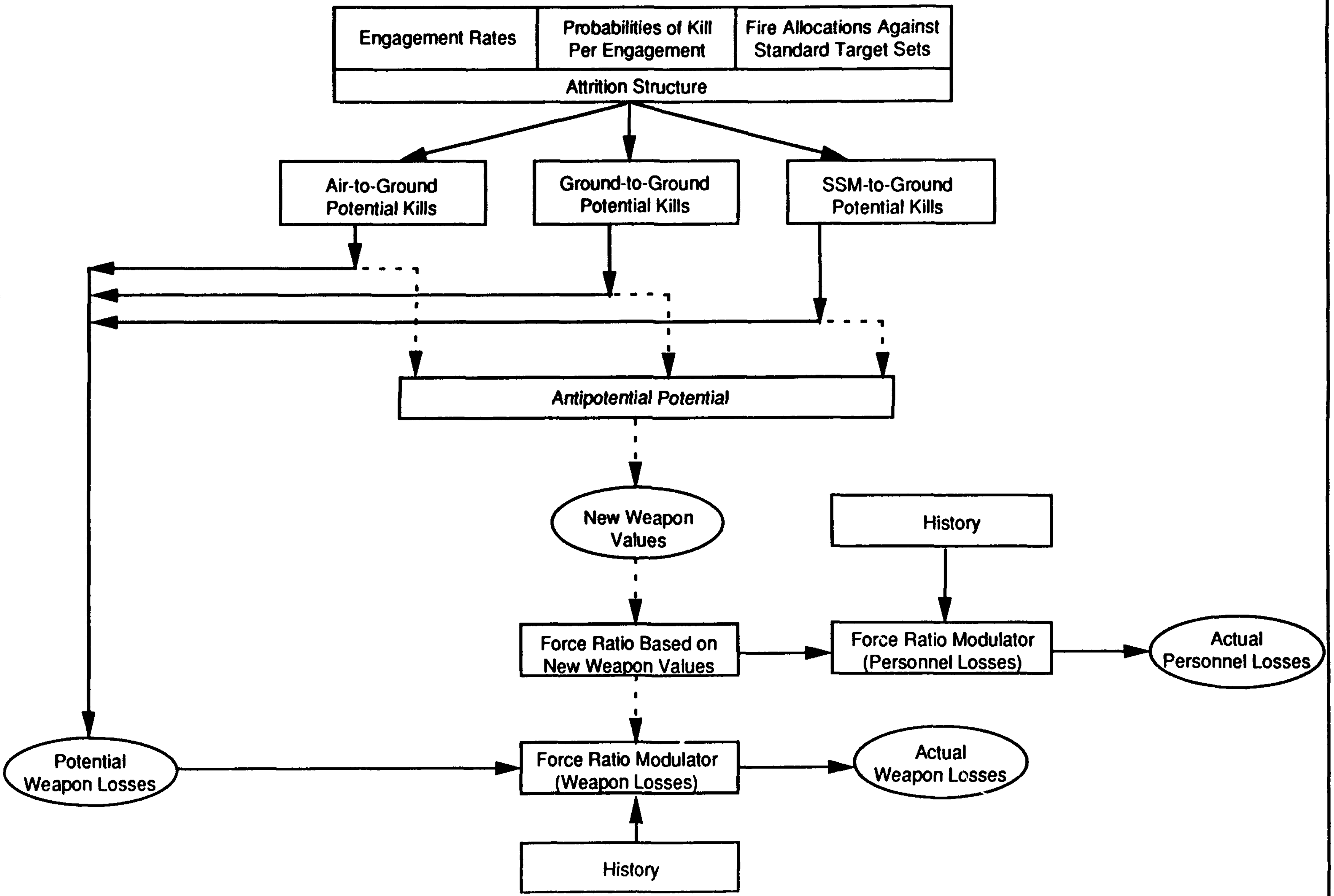
    A. Calculations
    B. Personnel and Supply Losses
    C. Weapon Losses.

GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

ATTRITION CALCULATIONS

- Values of individual weapons and aircraft sorties are computed by the antipotential potential (APP) method.
- The APP method is a complex approach to the problem of computing the value of a weapon based on its capability to destroy the value of the enemy weapons.
- The antipotential potential technique uses an iterative eigenvector procedure to place both sides weapons on a common scale of values that is based on the value of a single Blue reference weapon.
- As an option, weapon values may be input directly.
- The procedure yields a constant, derived from the eigenvalue of a weapon-on-weapon kill rate matrix, that is used for ground weapons.
- The ground submodel determines personnel effectiveness on attack and defense, as a function of personnel strength, and supply effectiveness as a function of supplies on hand.
- Another attrition technique available is the potential number of weapons lost method. The user has the option of using either attrition technique.
- The potential number of weapons lost calculation determines weapon and personnel casualties based on user input fractions that state how many Red weapons would be killed if a Blue weapon which was on the defensive was firing at it.

OVERVIEW OF TACWAR GROUND ATTRITION METHODOLOGY



GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

ATTRITION CALCULATIONS (Continued)

- Then multiplying the total allocation of individual weapons firing against the attacking weapons gives the potential number of Red weapons killed.
- Once the potential value at each side has been determined, the model next determines which side is the attacker in the sector under consideration. (The theater attacker is designated by the user at the beginning of the game and is changed, if appropriate, by the theater control model.)
- To determine which side is attacking in a sector, TACWAR computes the sector force ratios, considering each side's total air and ground weapon value on defense and on attack.
- Even though one side may have a superior force in a sector, that side will not be designated the sector attacker unless the force ratio equals or exceeds a user-specified threshold. A holding posture may exist if neither side is strong enough to attack.
- Since the computation of personnel and weapon attrition depends upon the computation of force ratios, it is obvious that the most important operation performed by the ground model is the determination of each side's weapon values and the force ratios derived from them.
- The force ratios developed by the model have both air and ground components. For the purpose of computing force ratios, the ground strength of a side consists of the collective value of that side's ground weapons.

GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

STEPS IN THE ATTRITION PROCESS

1. The allocated potential of Blue weapon i against Red weapon j is computed considering Blue's allocation of fire, number of Red Weapons, and the potential of Blue weapon i against Red weapon j

$$K_{ij}^{bw} = F\left(A_{ij}^{br}, N_j^r, P_{ij}^{bw}\right), \quad K_{cj}^{ba} = G\left(L_{cm}^{ba} \; A_{mj}^{br}, N_j^r, P_{mj}^{ba}\right)$$

2. This is translated into the weapon value of Blue weapon i to cause casualties and destroy weapons within the Red force by considering the weapon value destroyed when Red weapon j is killed by Blue weapon i.

$$V_i^{bw} = \alpha_1 \sum K_{ij}^{bw} \; V_j^{rw}, \quad V_c^{ba} = \alpha_2 \sum K_{cj}^{ba} \; V_j^{rw}$$

3. Adding the weapon value from 2 above over all Blue weapons in the sector produces the total Blue weapon value measured in Red weapon value destroyed.

$$V^{bw} = \alpha_1 \sum_i N_i^b \sum_j K_{ij}^{bw} \; V_j^{rw}, \quad V^{ba} = \alpha_2 \sum_c S_c^b \sum_j K_{cj}^{ba} \; V_j^{rw}$$

4. Ratio of corresponding Red and Blue weapon values are used with empirical data to produce Red and Blue casualties and weapons destroyed.

Casualties: $\dot{B}_0 = f\left(V^r / V^b\right) B_o$ and $\dot{R}_o = g\left(V^r / V^b\right) R_o$

Weapon Value: $\dot{V}^b = f\left(V^r / V^b\right) V_o$ and $\dot{V}^r = g\left(V^r / V^b\right) V_o$

Weapon Lost: $\dot{N}_i^b = \left(\dot{N}_i^{bp} / \sum_k \dot{N}_k^{bp}\right)$ and $\dot{N}_j^r = \left(N_j^{rp} / \sum_k \dot{N}_k^{rp}\right) \dot{V}^r$

AttriModeling4

GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

ATTRITION CALCULATIONS (Continued)

- The air strength of a side is the collective value of the successful CAS sorties that side flies.
- A standard force ratio is the ratio of the attacker total air and ground strength to the defender total air and ground strength

Where

S_i^s = the number of type-i shooters ($1 \le i \le M$)

T_j^t = the number of type-j targets ($1 \le j \le N$); and

$\dot{T}_j^t$ = the number of type-j targets killed ($1 \le j \le N$).

$D_{\iota m}^{st}$ = the probability that a shooter in category s detects a target in category t, given that the location of the interaction is given by ι and that m is as described above.

K_{ij}^{st} = the probability that a type-i shooter in category s kills a type-j defender in category t, given that the shooter has detected the target.

GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

ATTRITION CALCULATIONS (CONTINUED)

General Form

$$\dot{T}_j^t = f\left(S_1^s, \ldots, S_M^s, T_j^t, r^t, D_{\iota m}^{st}, K_{1j}^{st}, \ldots, K_{Mj}^{st}\right)$$

Attrition Equations

1. Single-engagement binomial attrition equation

$$\dot{T}_j^t = T_j^t \left(1 - \prod_{i=1}^{M} \left[1 - \frac{K_{ij}^{st}}{\bar{T}^t}\left(1 - \left(1 - D_{\iota m}^{st}\right)^{\bar{T}^t}\right)\right]^{S_i^s}\right).$$

2. Exponential approximation to 1.

$$\dot{T}_j^t = T_j^t \left(1 - \exp\left[-\frac{\sum_{i=1} S_i^s K_{ij}^{st}\left(1 - \exp\left[-D_{\iota m}^{st}\bar{T}^t\right]\right)}{\bar{T}^t}\right]\right).$$

3. Another exponential equation

$$\dot{T}_j^t = T_j^t \left(1 - \exp\left[-\frac{\sum_{i=1}^{M} S_j^s K_{ij}^{st} D_{\iota m}^{st}}{\bar{T}^t}\right]\right)$$

GROUND COMBAT SUBMODEL SUPPLEMENT - ATTRITION MODELING

ATTRITION CALCULATIONS (CONCLUDED)

Attrition Equations (Concluded)

4. **Multiple engagement binomial attrition equation**

$$\dot{T}^{j}_{\iota} = T^{t}_{j}\left(1 - \prod_{i=1}^{M} \left(1 - D^{st}_{\iota m} K^{st}_{ij}\right)^{S^{s}_{i}}\right) .$$

5. **Lanchester square equation**

$$\dot{T}^{t}_{j} = \frac{T^{t}_{j}}{\bar{T}^{t}} \sum_{i=1}^{M} D^{st}_{\iota m} K^{st}_{ij} S^{s}_{j} .$$

6. **Lanchester linear equation**

$$\dot{T}^{t}_{j} = T^{t}_{j} \sum_{j=1}^{M} D^{st}_{\iota m} K^{st}_{ij} S^{s}_{j} .$$

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GROUND COMBAT SUBMODEL SUPPLEMENT

PERSONNEL AND SUPPLY LOSSES

- To calculate the value lost for both sides, force ratios are recomputed as the sum of the value of ground forces and air forces (times the fraction of CAS sorties considered) divided by the value of the opponent's ground and air forces.

- The model computes the casualty percentages as a function of posture and force ratios. The value lost and, hence, casualties for each side may then be determined from these percentages by applying these percentages to the units involved according to their individual contributions.

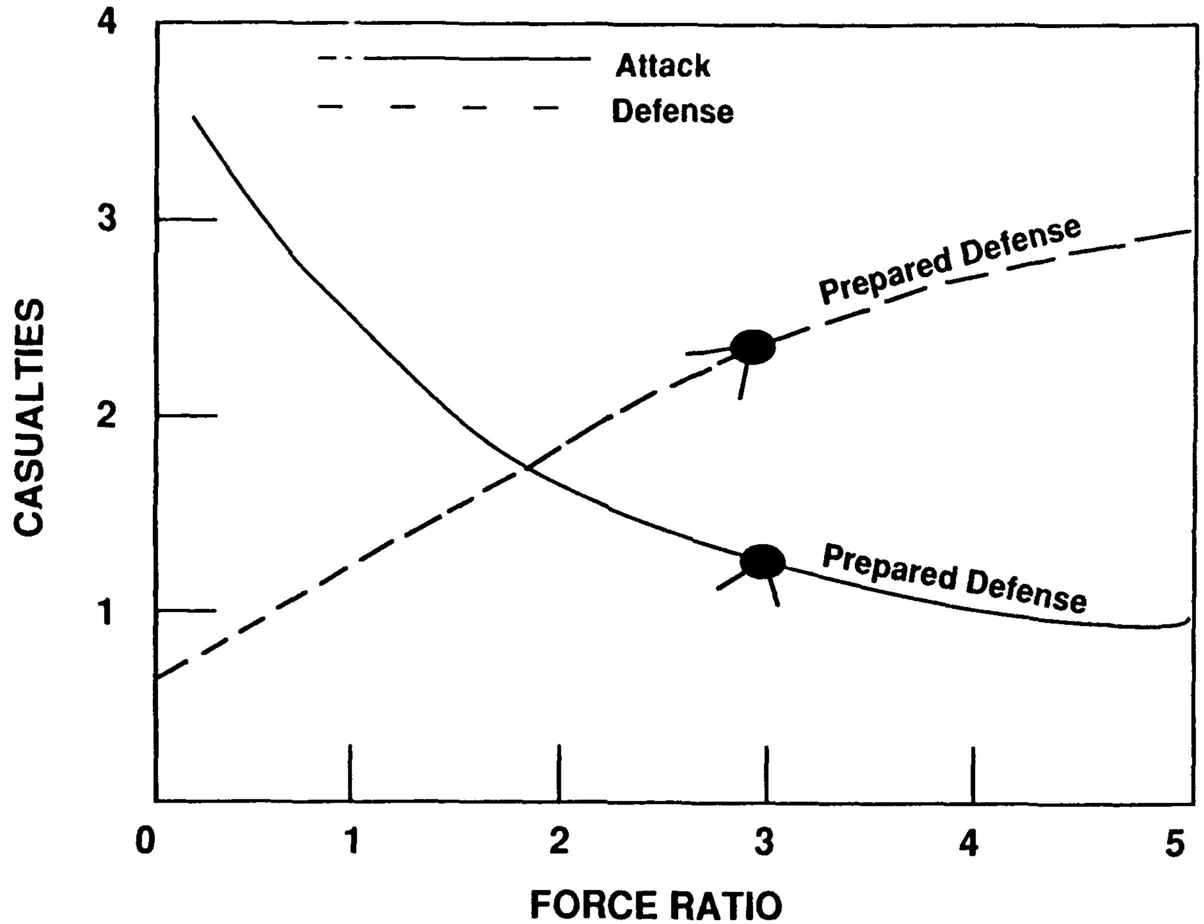
- Another important feature of the ground combat routine is the modeling of supply consumption and destruction. The consumption of supplies by ground forces is based on division consumption rates input by the user.

- Supplies may be destroyed by attacking CAS or INT aircraft, or by ground weapons during the course of battle. Each type of attacking weapon is assumed to destroy some user-set amount of enemy supplies in the combat sector.

- Each successful CAS sortie is assumed to destroy some fixed amount of supplies in addition to the weapon and personnel losses it causes.

- Pure supply-interdiction missions are also modeled.

CASUALTY RATE CURVES OF THE TYPE USED IN THEATER MODELS



NOTE: **To simplify the graph, curves for other posture/mission combinations are omitted. Casualty rates are in daily percentages.**

Source: Research Analysis Corporation, NATO Combat Capabilities Study, Volume IV, Impact of Losses and Replacements on Unit Combat Capability.

CasRateCurves...

GROUND COMBAT SUBMODEL SUPPLEMENT - FLOT/FEBA

FLOT/FEBA MOVEMENT AND CONSTRAINTS TO MOVEMENT

- This subsection describes how the movement of the FLOT/FEBA is calculated for each battle area under consideration. Throughout this subsection, it is assumed that Red is on attack in the battle area and that Blue is defending in posture-type k. (The case for Blue on attack is handled symmetrically.)
- The FLOT/FEBA movement module is a significant part of the TACWAR simulation because FLOT/FEBA motion is one of the primary orders of merit regarding the outcome of a battle.
- As previously mentioned in the ground module logic discussion, the ground module provides the FLOT/FEBA module *with a temporary* FLOT/FEBA location.
- The FLOT/FEBA module takes that information and adjusts the motion of the FLOT/FEBA to account for force ratios, terrain effects, flank exposure constraints, combat deployments, unit combat posture, and the mobility inherent in the attacker divisions.
- This discussion will include:

  A. Basic Equation

  B. Constraints on Movement.

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GROUND COMBAT SUBMODEL SUPPLEMENT - FLOT/FEBA

BASIC EQUATION FOR FLOT/FEBA MOVEMENT CALCULATION

- The movement of the FLOT/FEBA is determined using the following basic equation. The FLOT/FEBA movement in a battle area is calculated as:

$$F = \mu \cdot f \frac{(A^a + G^a)}{(A^d + G^d)}$$

F = FLOT/FEBA movement (km per cycle).

μ = Mobility factor of attacker, as a function of:

-- Division type
-- Terrain
-- Posture (attack/delay, breakthrough).

f = Input function relating force ratio to basic FLOT/FEBA movement per cycle, as a function of:

-- Posture
-- Terrain.

A^a = Aggregate attacker air value in battle area.

G^a = Aggregate attacker ground value in battle area.

A^d = Aggregate defender air value in battle area.

G^d = Aggregate defender ground value in battle area.

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GROUND COMBAT SUBMODEL SUPPLEMENT - FLOT/FEBA

BASIC EQUATION FOR FLOT/FEBA MOVEMENT CALCULATION (Continued)

- The final FLOT/FEBA movement for this battle area is that value that gives the same force ratio as calculated via the APP method.

  -- The FLOT/FEBA movement rate defines the distance that the FLOT/FEBA moves within each sector during the course of a 12-hour combat cycle.

  -- This movement is synonymous with the rate of advance of the sector attacker and, accordingly, may add to or subtract from the cumulative distance that a theater attacker has advanced.

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GROUND COMBAT SUBMODEL SUPPLEMENT - FLOT/FEBA

CONSTRAINTS OF MOVEMENT

- Combat models that are based on the sector movement concept can develop large combat salients in one or more sectors while movement in adjacent sectors is negligible. TACWAR allows a user to prevent such unrealistic salients from developing by limiting the amount of advance permitted in any sector based on the motion in adjacent sectors. A concept of flank exposure of the attacker or the defender in conjunction with sector width is used to determine how far an attacking force can penetrate.

- A front-to-flank ratio for FLOT/FEBA adjustments, can cause:

  -- An *attacker to be constrained* if the current front-to-flank ratio is less than some user-provided value. Movement is not constrained if the current ratio is greater than or equal to the value

  -- A defender can withdraw if one of the exposed flanks is too large. That is, for each sector, first one flank, then the other is tested; then the sum of the two exposed flanks is tested. If the exposed flank is too large in any one of these tests, the defender position is adjusted.

  -- An attacking force that is extended beyond adjacent sectors (to the extent that each flank of the sector is longer than the sector width) not to advance even though the engagements result would allow it to do so.

  -- A defending force to withdraw in each sector until it has, at most, one exposed flank. If only one flank is exposed at the end of a period, no adjustment is made.

FLOT/FEBA4

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT - FLOT/FEBA

CONSTRAINTS ON MOVEMENT (Concluded)

- It should be noted that TACWAR (and most other models) have few other rules for adjusting the FLOT/FEBA even though there are other factors that may help or hinder sector advance. The factors not modeled in TACWAR include the availability of additional forces, e.g., Spetznatz Forces, better command and control.
- For the discussion that follows, it is assumed that the attacker objective is to develop at least a holding force-ratio in all sectors other than the Sector of Main Attack (SMA). In the SMA, the attacker wants to achieve a force ratio that (with a high probability) will assure a successful attack (i.e., a high attack force-ratio).
- However, to be able to advance beyond some reasonable distance in the SMA, even with an adequate attack force-ratio, the attacker needs to have a reasonable number of rear-guard and flank security forces.
- These security forces prepare a defense against counterattacks by the defending force against the attacker rear. The amount of combat power that an attacker must hold over a defender to protect his own flanks and rear successfully is defined as the security force-ratio.
- For a typical attack, it is assumed that the attacker may advance the FLOT/FEBA in any sector to the point where one flank is exposed to the user-input distance.
- Additional FLOT/FEBA advance is possible, provided that there are additional forces acting as rear-guard and flank security forces in the forward most inactive battle area of the sector to generate the required security force-ratio.

FLOT/FEBA5

IDA

HERO-IDENTIFIED FACTORS POTENTIALLY INFLUENCING RATES OF ADVANCE

- Force ratio of opposing forces.
- Force mix of advancing forces.
- Force mix of defender.
- Mission of advancing or attacking force.
- Mission of defending or withdrawing force.
- Posture of defending or withdrawing force.
- Terrain, as related to ruggedness and terrain obstacles.
- Weather.
- Season.
- Mobility considerations:
  a. Road net, general
  b. Road net, capacity
  c. Cross-country traversibility.

- Intensity of engagements, in terms of casualties incurred and inflicted.
- Intensity of engagements, in terms of lull time and engagement time.
- Adequacy of supply, in terms of theoretical availability during operation.
- Adequacy of supply, in terms of distribution during engagement.
- Rates of advance of adjacent divisions within corps.
- Rates of advance of adjacent corps.
- Endurance of men, in terms of periodic casualty rates before and during operation.
- Endurance of men, in terms of distance traveled before and during operation.
- Endurance of men, as related to other environmental factors such as weather, terrain, season, disease, etc.
- Endurance of equipment, in terms of distance traveled before and during operation.
- Endurance of equipment, in terms of replacements of damaged or worn out equipment.
- Air superiority status.

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

CALCULATION OF REPLACEMENTS (THREE METHODS)

- Individual replacement method
  - Units filled "on-line" with personnel and weapons from replacement pools
- Unit replacement method
  - Unit replaced when effectiveness drops to certain level
- Combination of the above methods

GCSS CalOfReplace

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

REPLACEMENT POOLS

- Pools for both personnel and weapons by type
- User-defined replacement rates
- Assets can be bought in via time-T

GROUND COMBAT SUBMODEL SUPPLEMENT

REPAIR POOLS

- Pools for both personnel and weapons by type
- User-defined percent of casualties put in pools
- User-defined repair rates
- Non-combat weapon losses put in pools

GCSS RepairPools

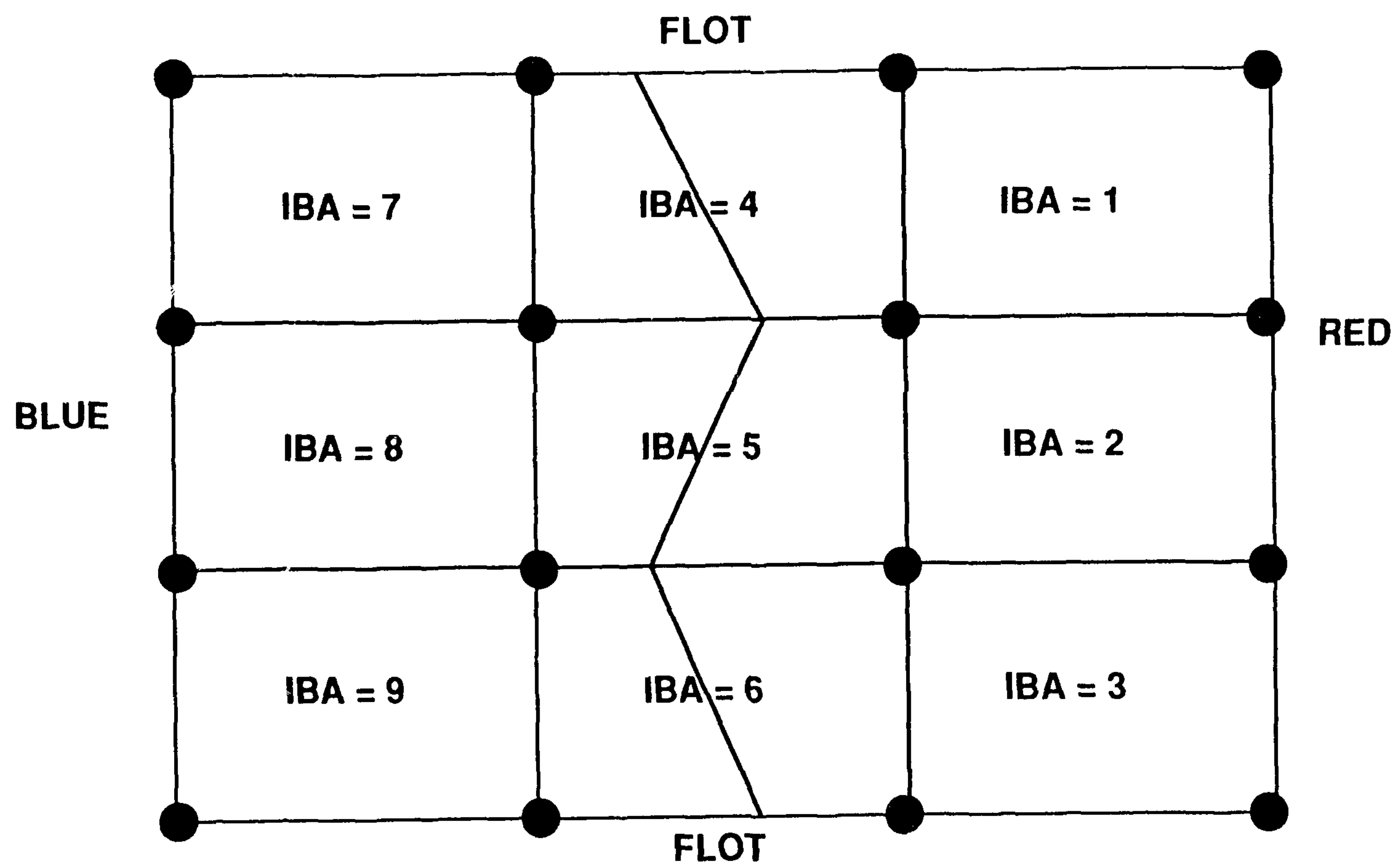
GROUND COMBAT SUBMODEL SUPPLEMENT

REINFORCEMENT OF POSITIONS

- Active battle area in each sector given priority
- Units moved up from inactive battle areas (if space)
  - -- Echelons utilized
    - ** Second echelon
    - ** *Third echelon*

IDA

BATTLE AREA NUMBERING EXAMPLE



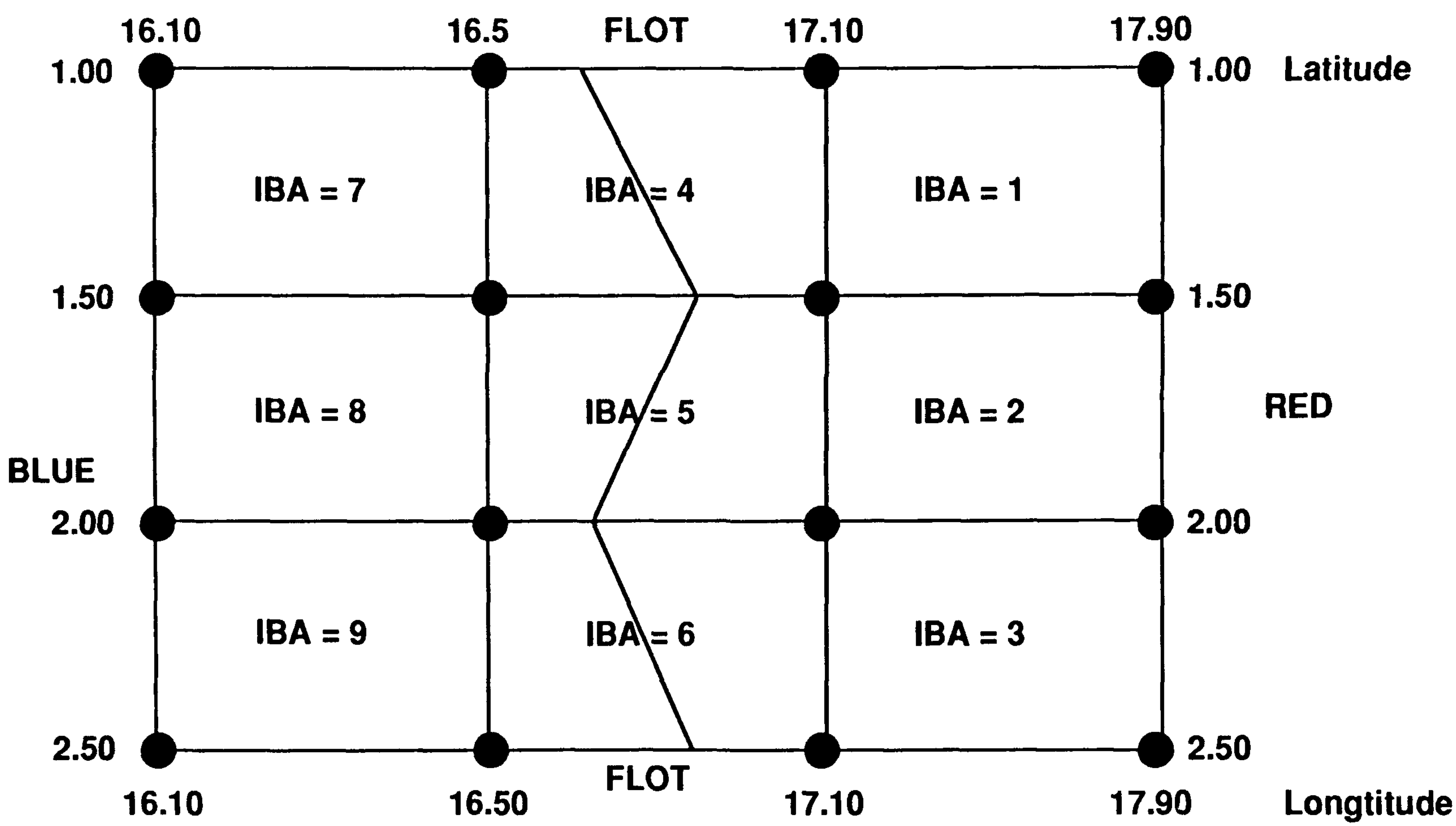
NS = 3

Total Battle Areas = 9

IBA = Battle Area Number

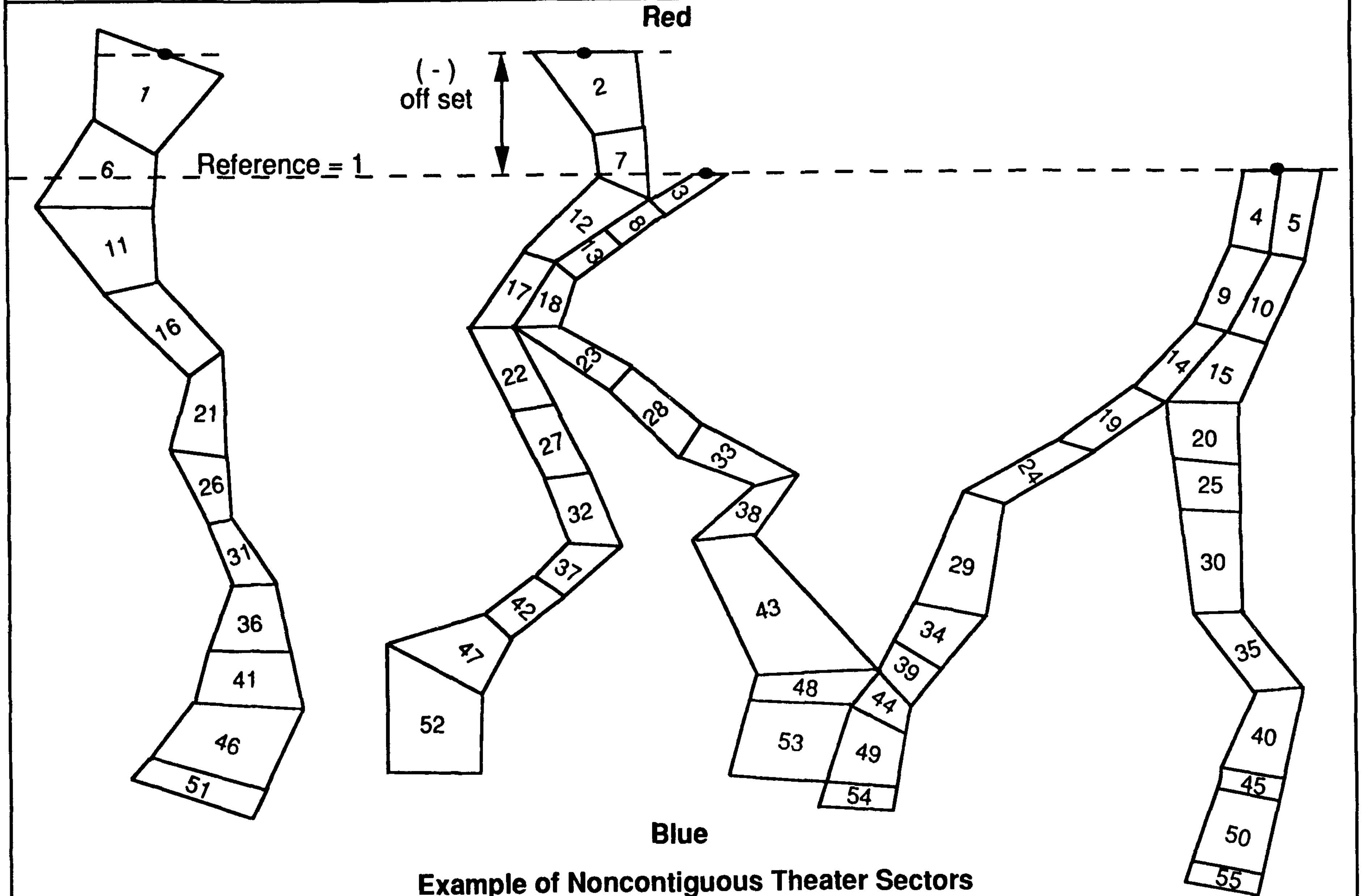
BA NumExam

BATTLE AREA NUMBERING EXAMPLE



RegionToSector

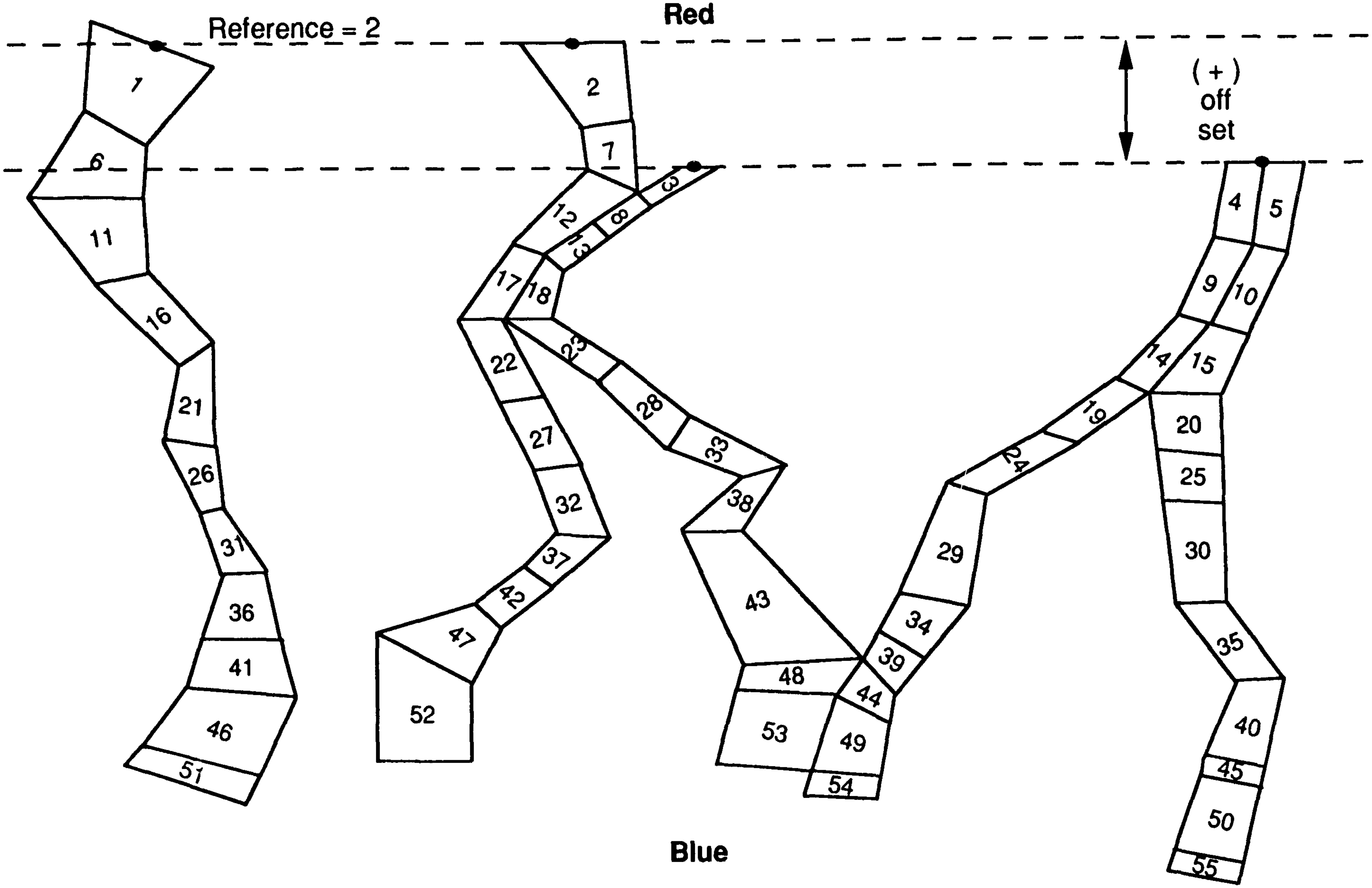
EXAMPLE OF NONCONTIGUOUS THEATER SECTORS



Example of Noncontiguous Theater Sectors

Rel 1 NTS

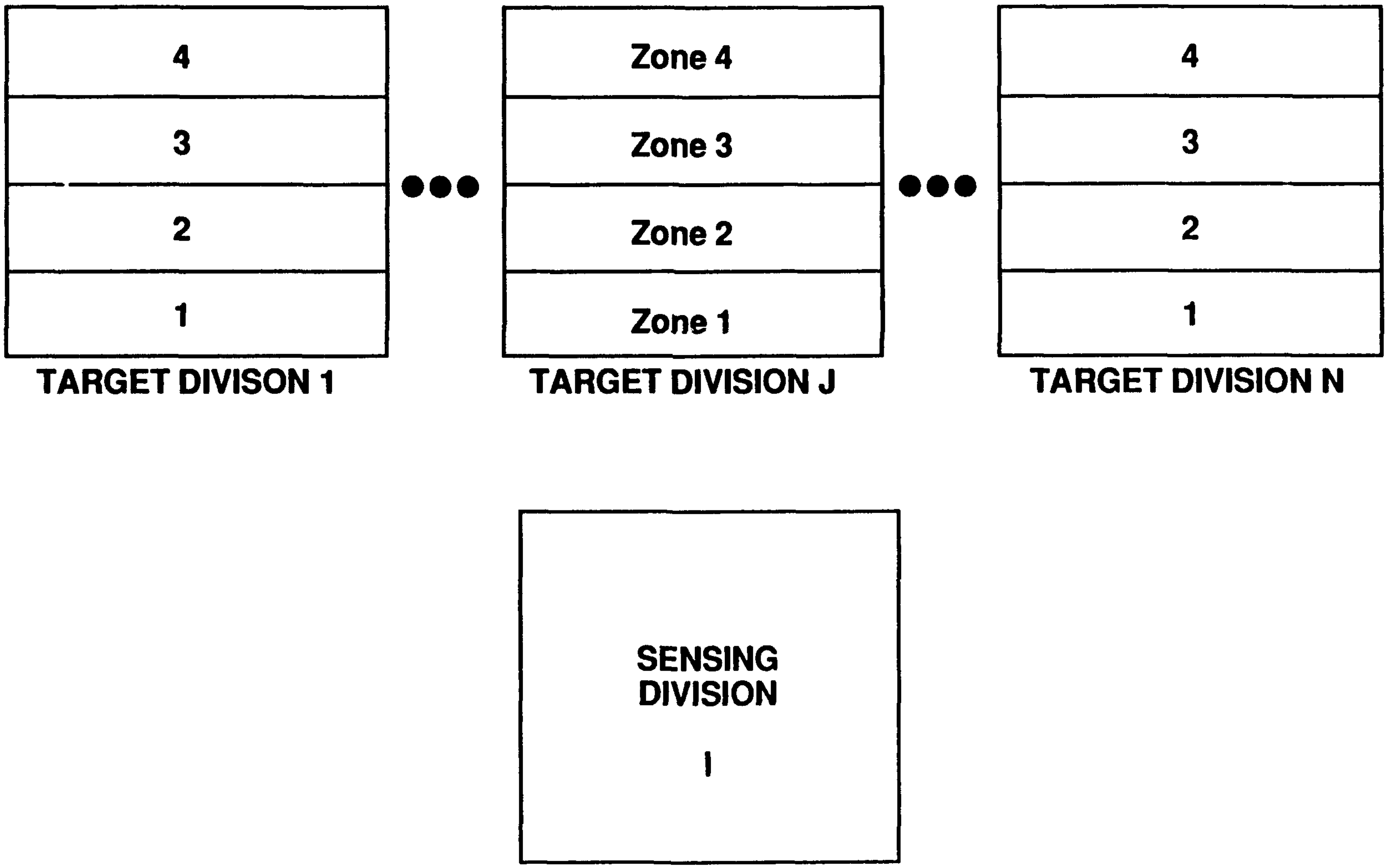
EXAMPLE OF NONCONTIGUOUS THEATER SECTORS



Example of Noncontiguous Theater Sectors

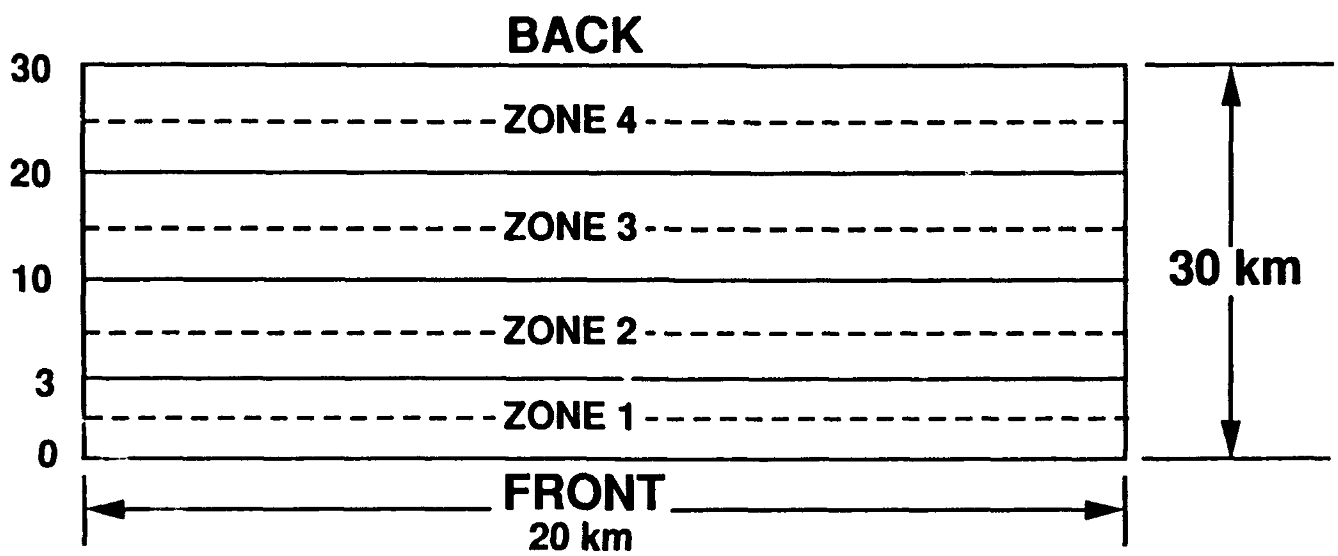
Ref 2 NTS

GENERAL PICTURE OF A BATTLEFIELD



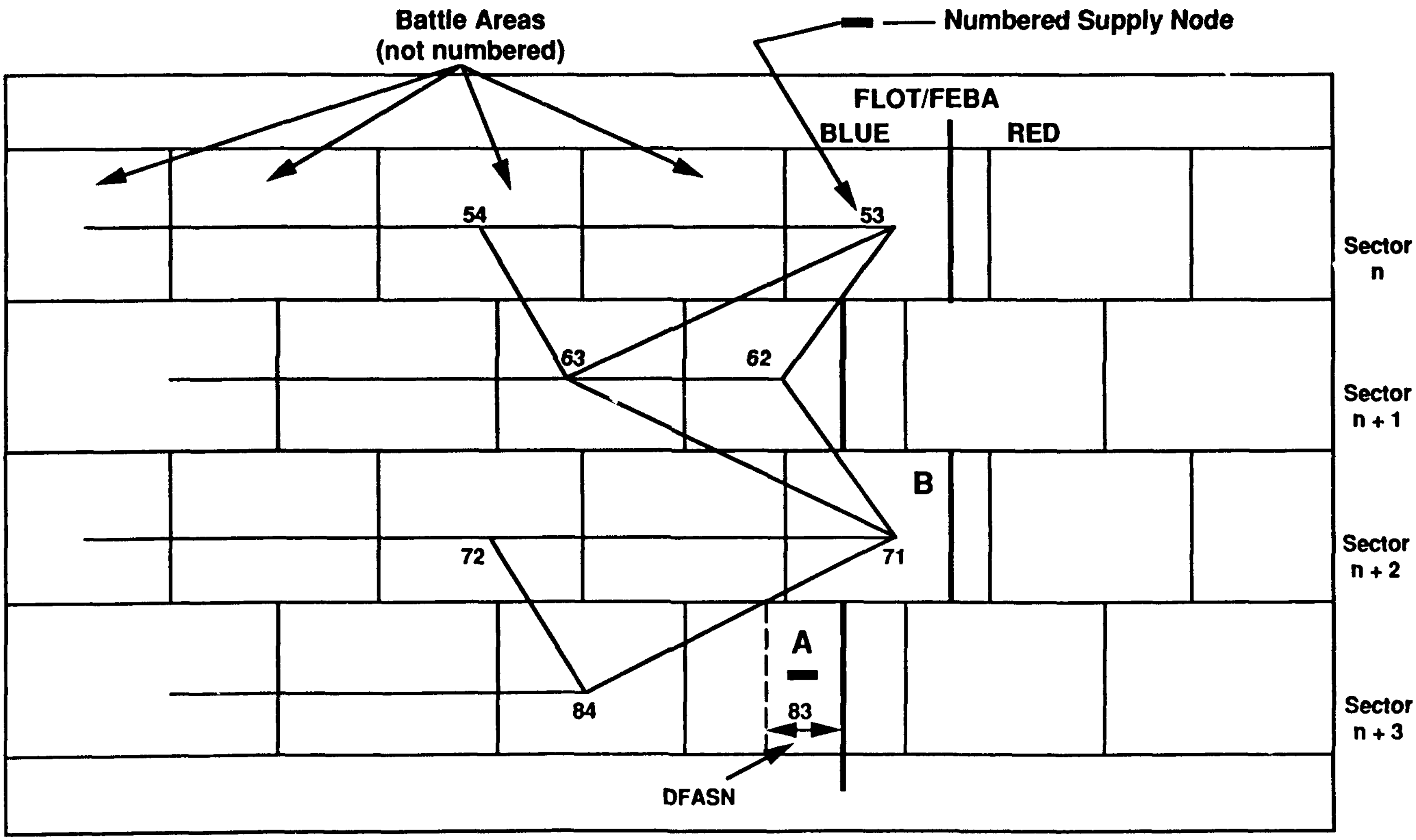
GenPicture...

ILLUSTRATION OF UNIT ARRAYS AND ZONES



IllustUnitArrays ..

TACWAR ORIGINAL SUPPLY NETWORK



OrigSupNetwork

IDA

SUPPLY SUBMODEL DESCRIPTION

- Determines the flow of supplies within the theater.
- Depicts ports, supply depots, and transportation centers.
- Represents roads, rail, waterways, and pipelines.
- Supplies may be destroyed by ground, SSM, and air weapons.
- Supply shortages reduce effectiveness of units and aircraft.

APPENDIX C

TACWAR ASSIGNMENT SUPPLEMENTS

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

UNIT ASSIGNMENTS FROM COMMZ LEVEL

- Units arriving in the theater preassigned locations may be processed by the Theater control logic at the Communication Zone (COMMZ) level, where they are assigned to specific regions. (Other logic assigns units from regions to sectors.)

- For the assignment of arriving units from COMMZ to regions, separate considerations are made for both the theater attacker and theater defender. For the theater attacker, the first arriving unit (for a given cycle) is assigned to that region containing the sector that is causing a sector of main attack to be constrained from moving bcause of flank exposure. If more than one sector of main attack is constrained, the first arriving unit is assigned to that region containing the sector (adjacent to a constrained sector of main attack) that has minimum FLOT/FEBA advance (as measured from initial FLOT/FEBA or from original base point).

- The second arriving unit (for a given cycle) is assigned to the region containing the sector (adjacent to constrained sector of main attack) that has the next least-advanced FLOT/FEBA. Assignments continue in this manner until all constrained sectors of main attack are accounted for, i.e., the appropriate region has been assigned one division per sector of main attack.

UnitAssign1

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

UNIT ASSIGNMENTS FROM COMMZ LEVEL (Continued)

- If none of the main attack sectors are constrained from moving, or if additional arriving units are still available, two assignment options are possible:

  -- Option 1. The arriving units are assigned, in order, to the various regions based on the amount of FLOT/FEBA advance of the sector of main attack. That is, the region containing the sector of main attack that has made maximum advance from the initial FLOT/FEBA location (or maximum advance from theater base location as defined by a user input) gets the first unit; the region containing the sector of main attack that is next in order of maximum FLOT/FEBA advance gets the second unit, and so on. Assignments continue until all sectors of main attack have been checked once, and if more units are available, the program begins with the original sector of main attack and repeats the cycle

  -- Option 2. Multiple unit arrivals (for a given cycle) are assigned, one at a time, to that region with the smallest force ratio for the theater attacker when all the forces in the active battle area plus the first inactive battle area of all the sectors of the region are considered. (Note: Assignment of units already made this day have been included.) Ties are broken in appropriate regions by choosing that region containing the sector with minimum advance from the initial FLOT/FEBA location (the base location as defined by a user input).

UnitAssign2

UNIT ASSIGNMENTS FROM COMMZ LEVEL (Concluded)

- For the theater defender, two assignment options are available
  - Option 1. The first arriving unit is assigned to that region containing the sector of maximum FLOT/FEBA advance (as measured from initial FLOT/FEBA or the base location as defined by a user input) upon consideration of all sectors in the theater. The second arriving unit and follow-on units are assigned, one at a time, to that region with the largest force ratio against the theater defender when all the forces in the active battle area plus the first inactive battle area of all the sectors of the region are considered. *Ties in force ratio value among regions are* broken by choosing that region containing the sector where the theater attacker has made maximum advance from the initial FLOT/FEBA (or the base location).
  - Option 2. Use the logic of largest force ratio value against the defender for all unit arrivals, with ties being broken as indicated above.

UNIT ASSIGNMENT FROM REGIONS TO SECTORS

- For both the theater attacker and theater defender, two options are possible:
  - -- Theater Attacker, Option 1

    (1) If the theater defender is attacking in any sector of this region, the theater attacker's first arriving unit is assigned to that sector. If the theater defender is attacking in more than one sector, the theater attacker's arriving unit is assigned to the sector of minimum FLOT/FEBA advance (advance as measured from either initial FLOT/FEBA or original base point) within those sectors where the theater defender is attacking.

    (2) If the theater attacker is either attacking in or constrained from moving in all sectors of the region, the unit assignment is made as follows:

    a. Check the sector of main attack to determine if it is constrained from moving. If not,

    b. Check the sector of maximum advance to determine if it is constrained from moving. If either of these sectors are constrained from moving, assign the arriving unit to the adjacent sector causing the constraint, but in the order indicated above. If neither sector is constrained, assign the unit to the sector of main attack.

    (3) For the other situations (such as sectors holding because of insufficient forces to attack) and for the assignment of successive unit arrivals on a given day, the following logic is used. The arriving units will be assigned, one at a time, to that sector of the region with smallest force ratio for the theater attacker when units in the active battle area and first inactive battle areas are considered. (Ties in the appropriate sectors are broken by choosing the sector with minimum FLOT/FEBA advance as measured from the initial FLOT/FEBA location or the base location.)

UnitAssign4

IDA

GROUND COMBAT SUBMODEL SUPPLEMENT

UNIT ASSIGNMENT FROM REGIONS TO SECTORS (Concluded)

-- Theater Attacker, Option 2

Use the logic in Option 1, Part 3 above, to assign all units to sectors from the region level, but break ties in the appropriate sectors by choosing minimum FLOT/FEBA advance (as measured from initial FLOT/FEBA location or theater base location).

-- Theater Defender, Option 1

(1) The first arriving division for the theater defender (in a particular *region) is assigned to that sector where the theater attacker has* advanced the most, i.e., the sector of maximum advance as measured from the initial FLOT/FEBA (or the base location).

(2) Successive unit arrivals on a given day are assigned, one at a time, to that sector of the region with the largest force ratio against the theater defender, with ties in appropriate sectors being broken by choosing that sector where the theater attacker has advanced the most (i.e., sector of maximum advance as measured from the initial time zero FLOT/FEBA or theater base location).

-- Theater Defender, Option 2

Use the logic in Option 1, Part 2, above with ties being broken as indicated.

UnitAssign5

GROUND COMBAT SUBMODEL SUPPLEMENT

UNIT ASSIGNMENT BY PROGRAM LOGIC

- The unit-control logic processes units arriving in the theater without preassigned locations at the COMMZ level. Here, units first go to regions and then to sectors. Once in sectors, they move forward toward the active battle areas of that sector--but if combat activity in an adjacent sector requires reinforcements, they can be switched by the user to the needy sector.

- When assigning units to regions from the COMMZ, the model considers if the side is on attack or defense. When on attack, the arriving unit goes to that region where the sector of main attack has the largest exposed flank constraint. If no such constraint exists, arriving units go to that region where the FLOT/FEBA location in the sector of main attack is ahead of all other main-attack sectors. For the defender, as a user option, the model will direct the arriving units to that region containing the sector where either the enemy has achieved their maximum FLOT/FEBA advance, or the defender faces the largest ground force-ratio. The first option is the default--once in the individual sectors using the same logic as just discussed, but on a more localized scale.

UnitAssign6

IDA

COMMZ TO REGION ASSIGNMENTS

THEATER ATTACKER ASSIGNMENTS (See variable ICADTA)

Tactical Situation	Unit Assignments Side 1 = CTA [a]	Unit Assignments Side 2 = CTA
One SMA [b] constrained	To region containing the constraining sector	To region containing the constraining sector
Multiple SMAs constrained	To region with sector of maximum FLOT/FEBA [c]	To region with sector of minimum FLOT/FEBA
No constrained SMAs (or multiple arrivals)	Option 1. In order of arrival to minimum FLOT/FEBA Option 2. In order of arrival to region with minimum FR (ties broken by maximum FLOT/FEBA)	Option 1. In order of arrival to maximum FLOT/FEBA Option 2. In order of arrival to region with minimum FR (ties broken by minimum FLOT/FEBA)

[a] CTA = current theater attacker (CTD = current theater defender).

[b] SMA = sector of main attack (sma = sector of maximum advance).

[c] FLOT/FEBA is determined by user to be either F_j or ΔF_j means FLOT/FEBA location in sector as measured from original base point, and ΔF_j means FLOT/FEBA advance in sector j from time zero FLOT/FEBA location.

COMMZtoRegion1

IDA

COMMZ TO REGION ASSIGNMENTS

THEATER DEFENDER ASSIGNMENTS (See variable ICADTD)

	Side 1 = CTD	Side 2 = CTD
Option 1	Unit #1 to maximum FLOT/FEBA; other units to region with sector of maximum FR against TD (ties broken by maximum FLOT/FEBA)	Unit #1 to minimum FLOT/FEBA; other units to region with sector of maximum FR against TD (ties broken by minimum FLOT/FEBA)
Option 2	Units assigned in order to region with sector of maximum FR (ties broken by maximum FLOT/FEBA)	Units assigned in order to region with sector of maximum FR (ties broken by minimum FLOT/FEBA)

COMMZtoRegion2

IDA

REGION TO SECTOR ASSIGNMENTS

THEATER ATTACKER ASSIGNMENTS (See variable IRADTA)

Tactical Situation	Unit Assignments Side 1 = CTA [a]	Unit Assignments Side 2 = CTA
Option 1		
CTD attacking in sector j	Unit assigned to sector j	Unit assigned to sector j
CTD attacking in many sectors	a. First unit assigned to sector of maximum FLOT/FEBA.[c] b. Follow-on units to sectors of next least advanced FLOT/FEBA (until all sectors where CTD is attacking have been considered).	a. First unit assigned to sector of minimum FLOT/FEBA. b. Follow-on units to sectors of next least advanced FLOT/FEBA (until all sectors where CTD is attacking have been handled).
CTA is attacking in and/or constrained from moving in all sectors	a. Check SMA.[b] If constrained, assign first unit to adjacent sector causing constraint. b. Check sma. If constrained, assign first unit to adjacent sector causing constraints. c. If neither the SMA nor the sma is constrained, assign the first unit to the SMA.	a. Check SMA. If constrained, assign first unit to adjacent sector causing constraint. b. Check sma. If constrained, assign first unit to adjacent sector causing constraint. c. If neither the SMA nor the sma is constrained, assign the first unit to the SMA.
For subsequent units arriving this day	Units arriving, in order, to sector of minimum FR (ties broken by maximum FLOT/FEBA)	Units arriving, in order, to sector of minimum FR (ties broken by maximum FLOT/FEBA)

[a] CTA = current theater attacker (CTD = current theater defender).

[b] SMA = sector of main attack (sma = sector of maximum advance).

[c] FLOT/FEBA is determined by user to be either F_j or ΔF_j means FLOT/FEBA location in sector as measured from original base point, and ΔF_j means FLOT/FEBA advance in sector j from time zero FLOT/FEBA location.

IDA

REGION TO SECTOR ASSIGNMENTS

THEATER ATTACKER ASSIGNMENTS (See variable IRADTA) (Continued)

Tactical Situation	Unit Assignments Side 1 = CTA	Unit Assignments Side 2 = CTA
Option 2 For the assignment of all units this day	Units assigned, in order, to sector of minimum FR (ties broken by maximum FLOT/FEBA).	Units assigned, in order, to sector of minimum FR (ties broken by maximum FLOT/FEBA).

THEATER ATTACKER ASSIGNMENTS (See variable IRADTD)

	Side 1 = CTD	Side 2 = CTD
Option 1 a. First arriving unit. b. Subsequent unit arrivals this day	a. To sector of maximum FLOT/FEBA. b. Units assigned, in order, to sector of maximum FR against defender (ties broken by maximum FLOT/FEBA).	a. To sector of minimum FLOT/FEBA. b. Units assigned, in order, to sector of maximum FR against defender (ties broken by minimum FLOT/FEBA).
Option 2 For the assignment of all untis this day.	Units assigned, in order, to sector of maximum FR against defender (ties broken by maximum FLOT/FEBA).	Units assigned, in order, to sector of maximum FR against defender (ties broken by maximum FLOT/FEBA).

APPENDIX D

TACWAR GRAPHS AND CHARTS

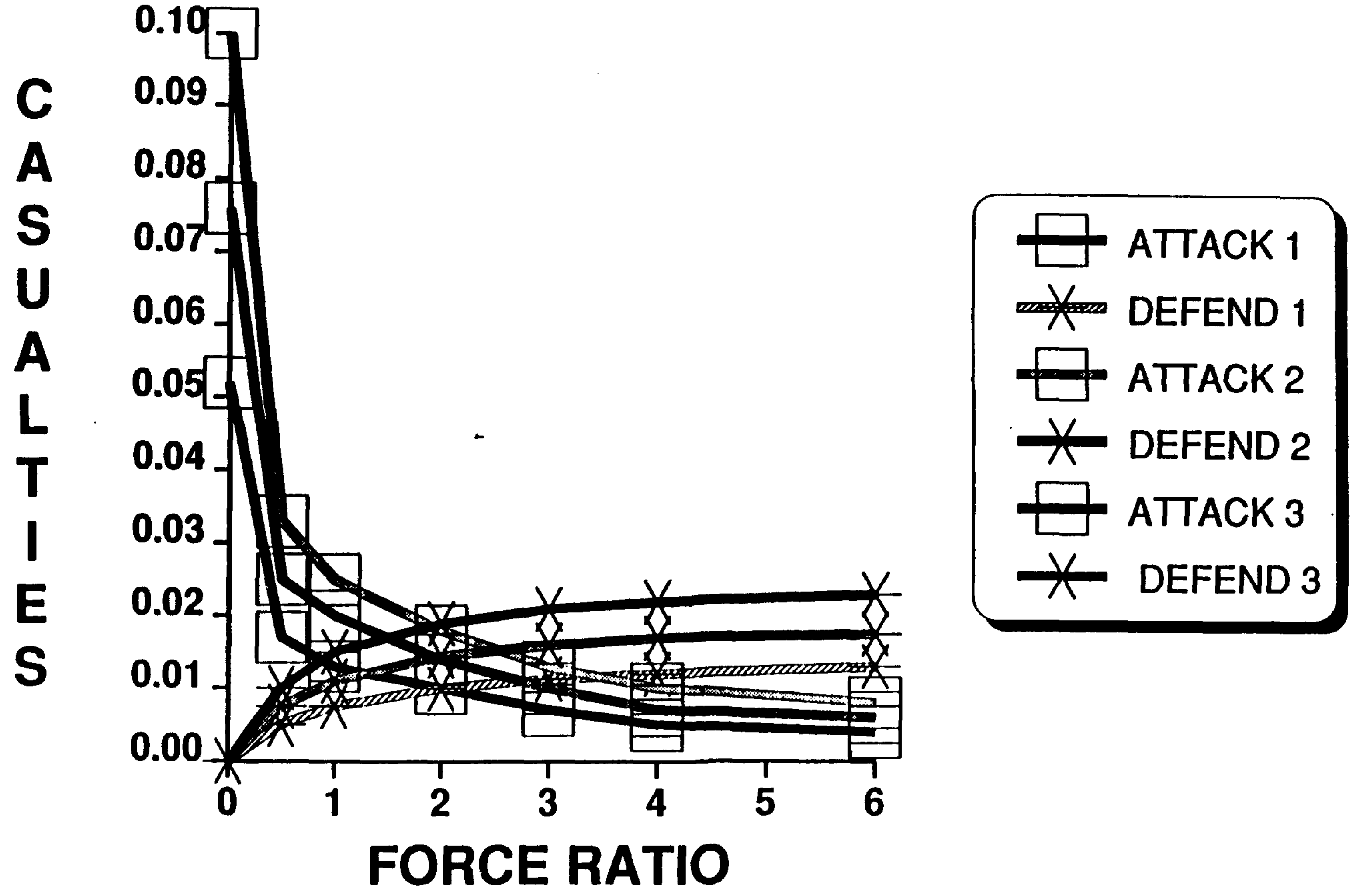
TABLE OF CONTENTS

1. FORCE RATIO VERSUS CASUALTIES AS USED IN THE IDA TACWAR MODEL

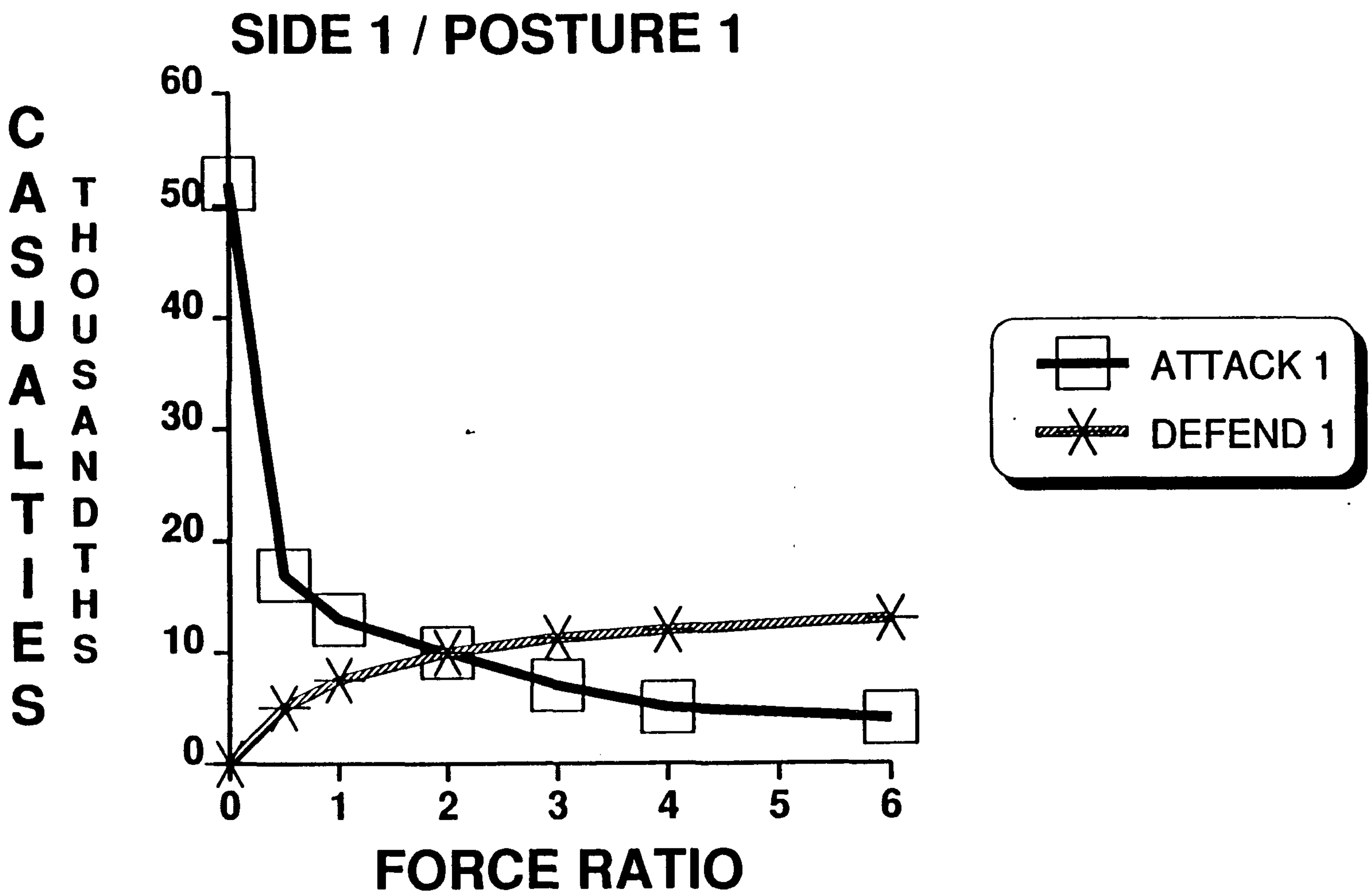
2. MOVEMENT CURVES USED IN THE IDA TACWAR MODEL

3. ASSORTED GROUND COMBAT MODELING RELATED CHARTS

FORCE RATIO VS CASUALTIES AS USED IN IDA'S TACWAR MODEL (1)

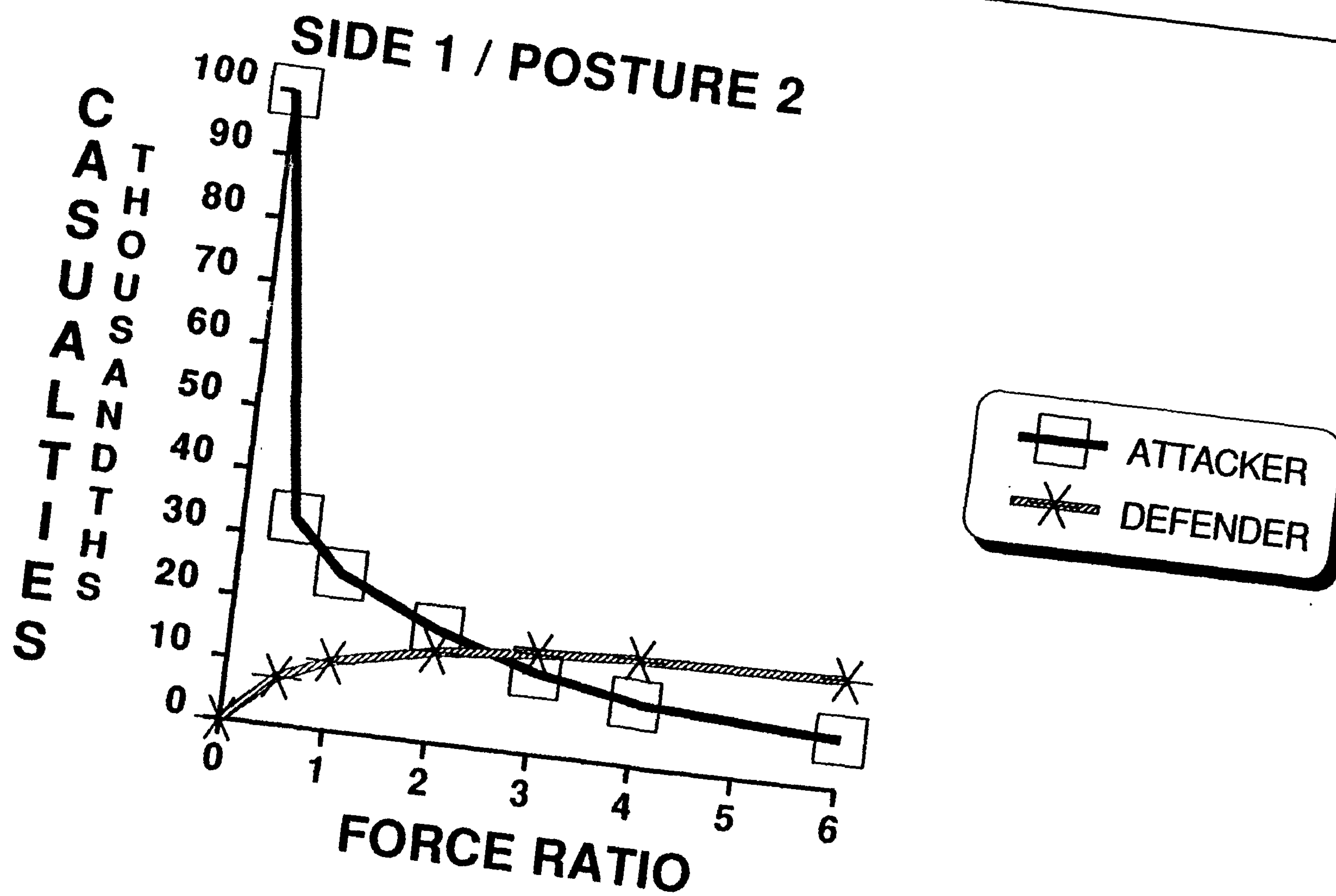


FORCE RATIO VS CASUALTIES AS USED IN IDA'S TACWAR MODEL (2)



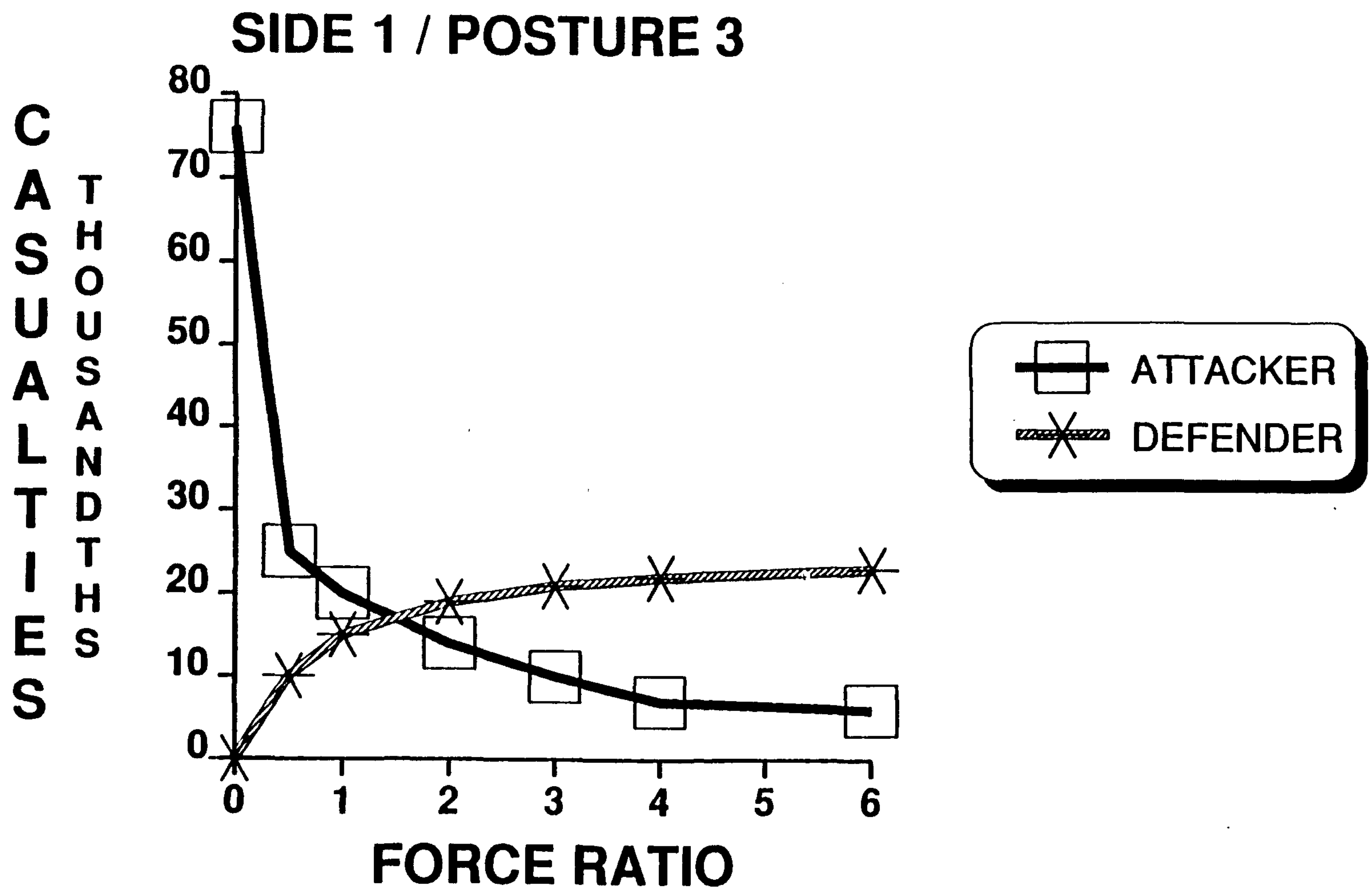
ForceRatioVsCas...

FORCE RATIO VS CASUALTIES AS USED IN IDA'S TACWAR MODEL (3)

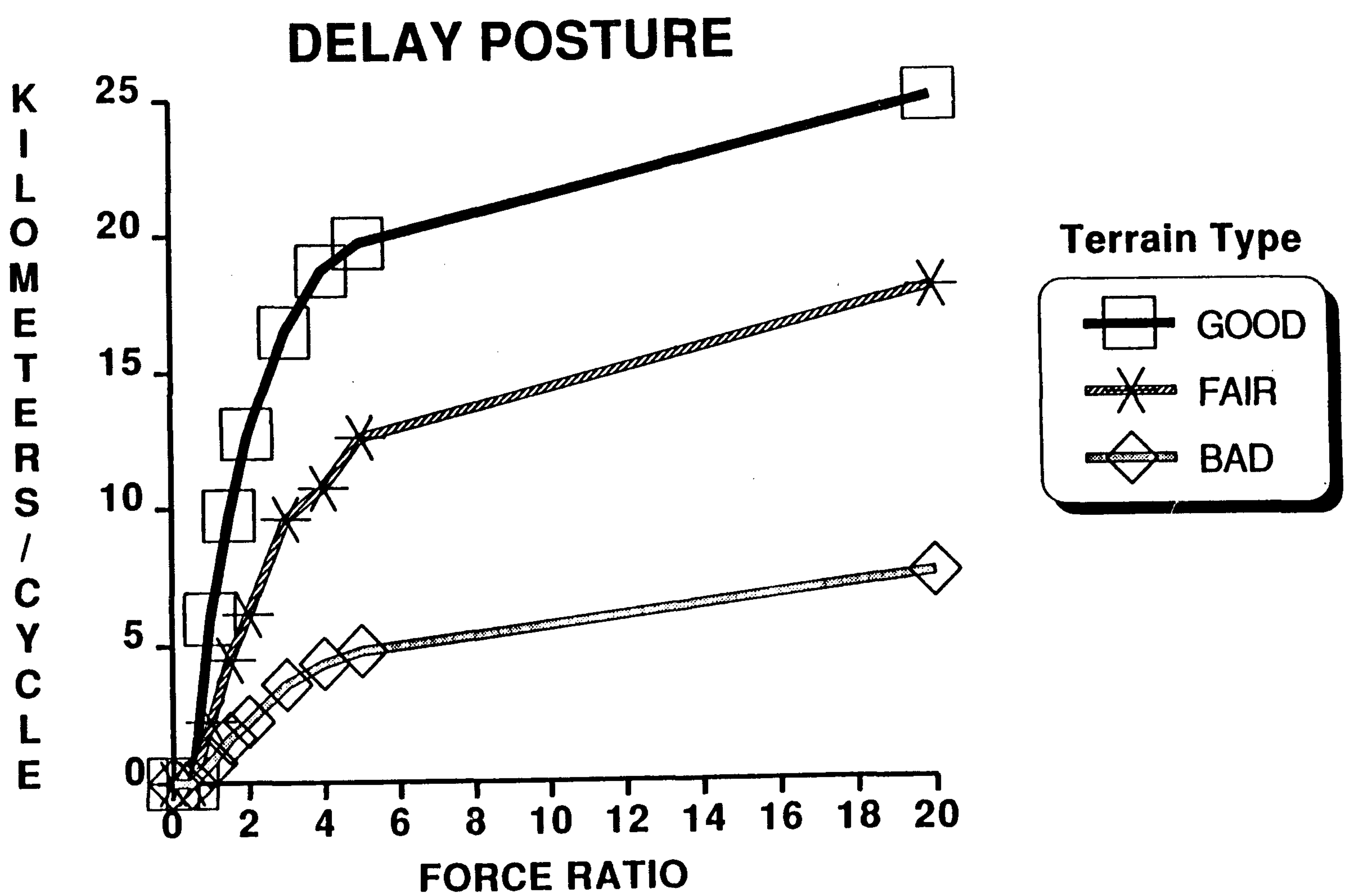


ForceRatioVsCas...

FORCE RATIO VS CASUALTIES AS USED IN IDA'S TACWAR MODEL (4)

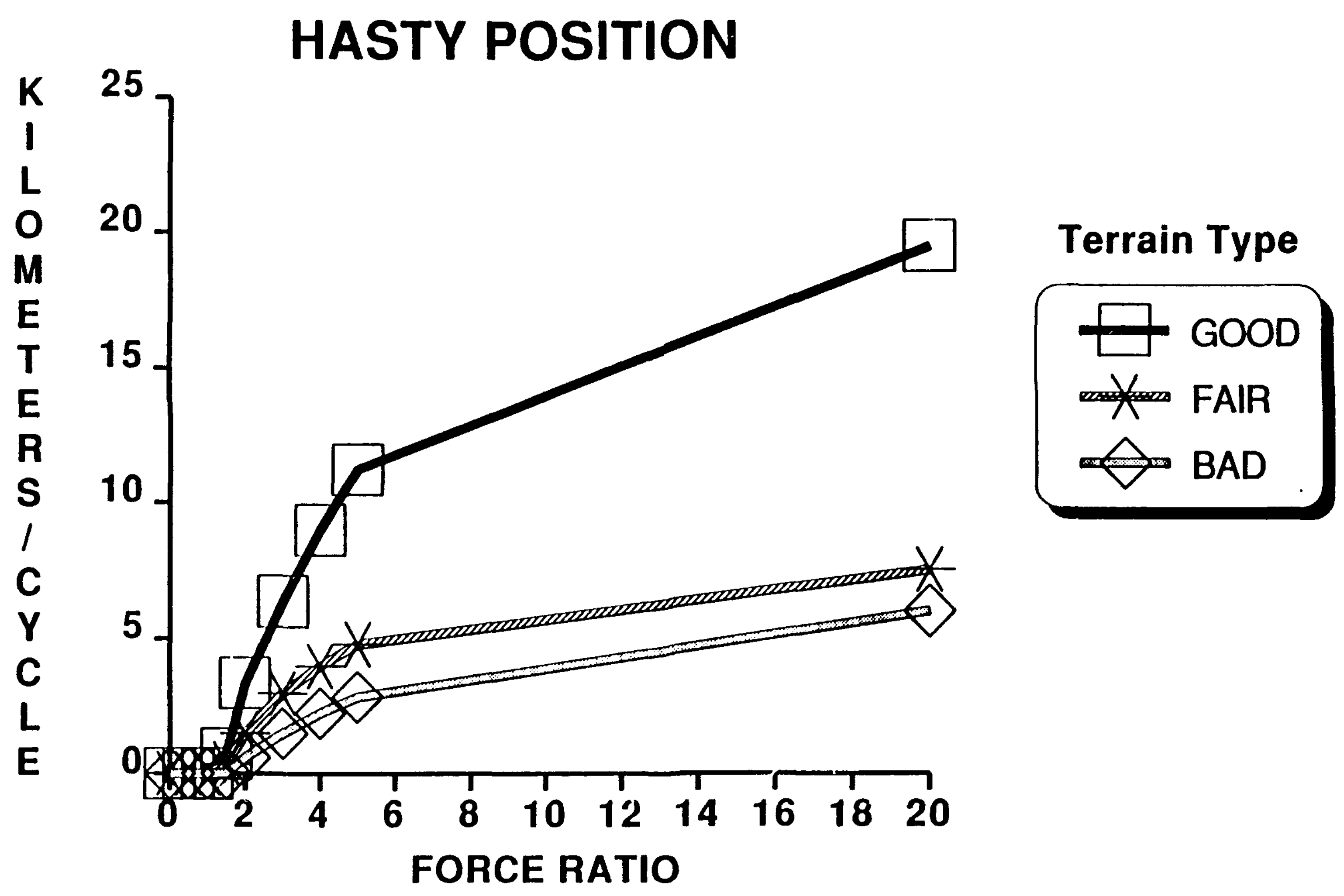


MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (1)



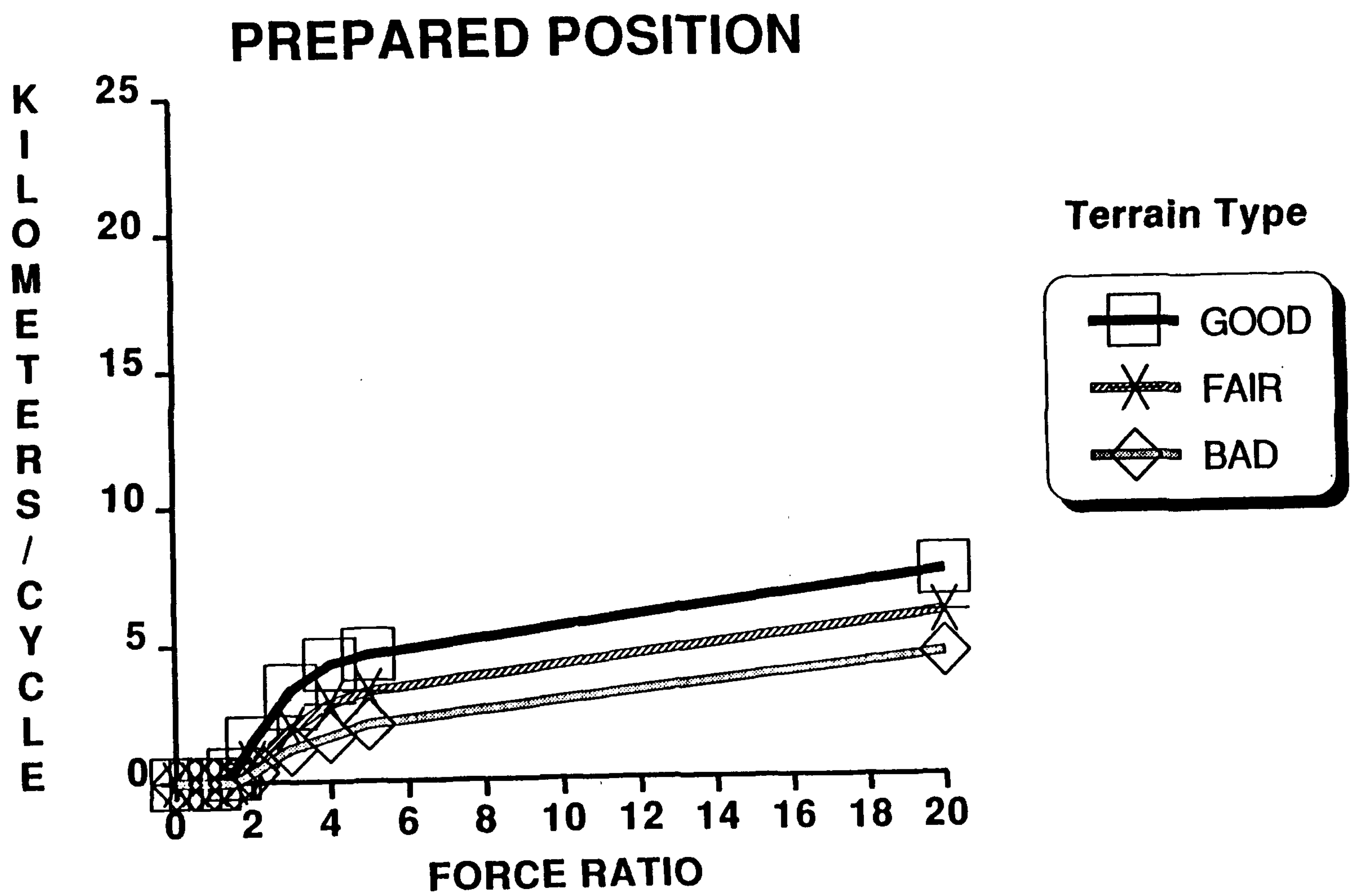
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (2)



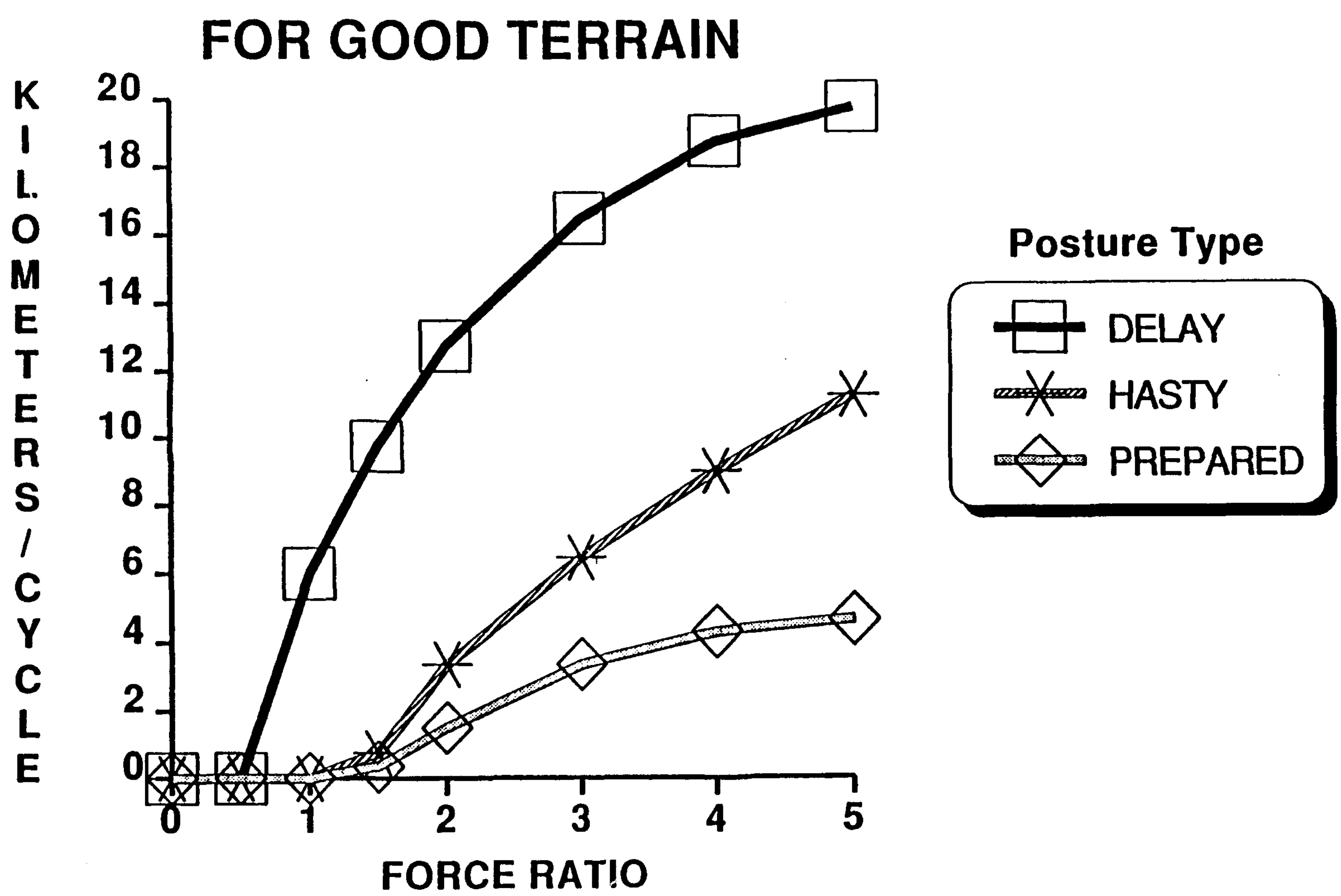
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (3)



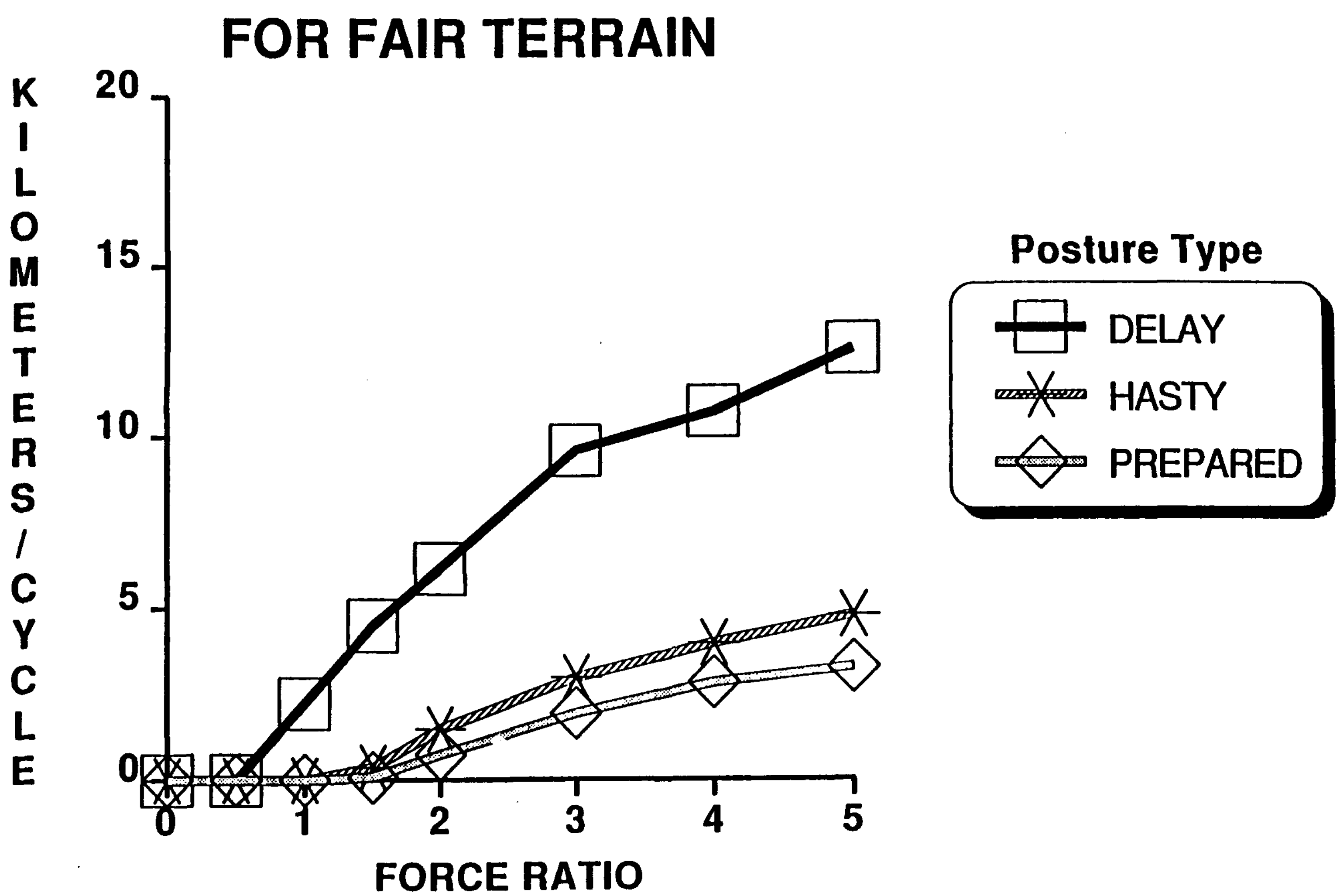
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (4)



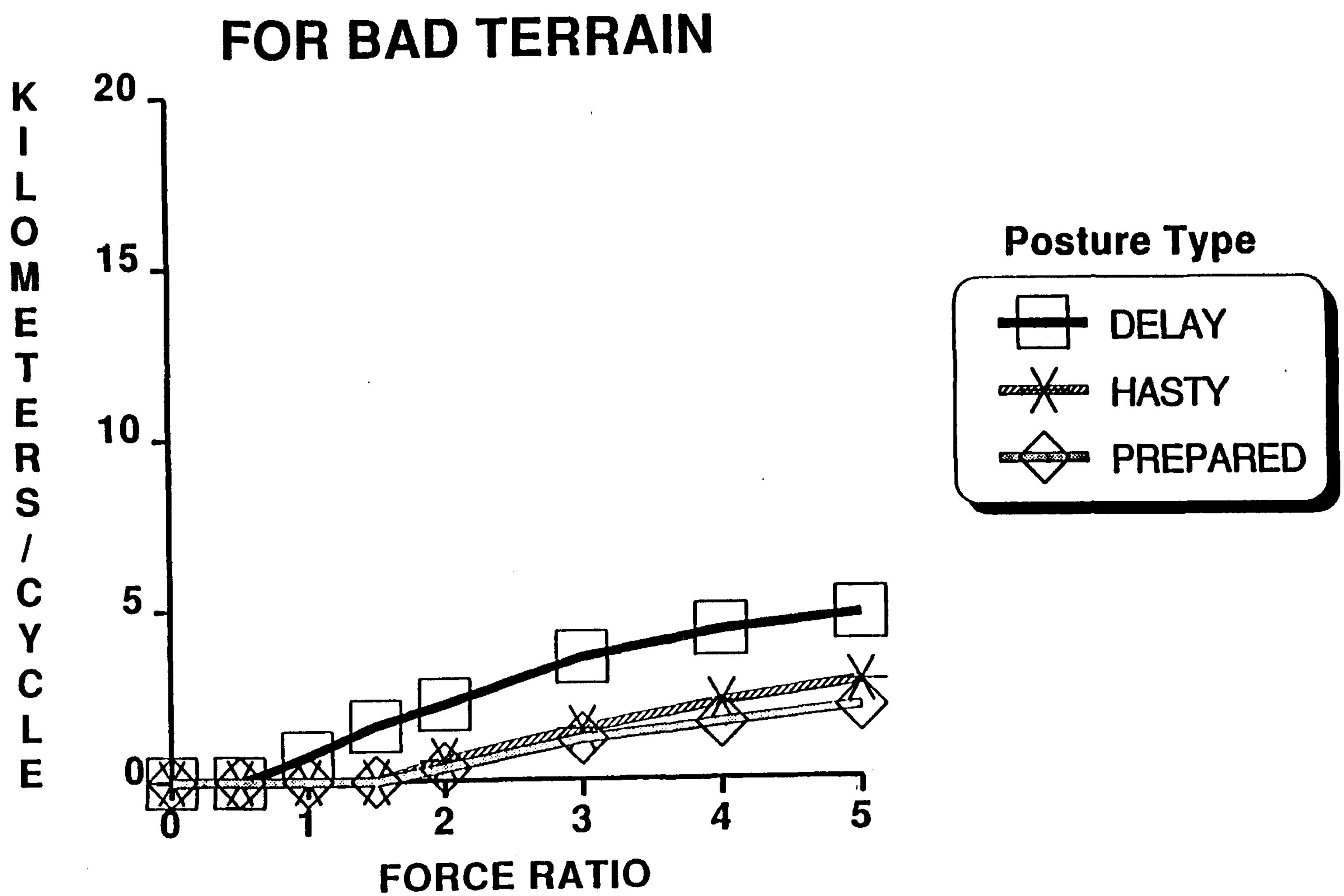
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (5)



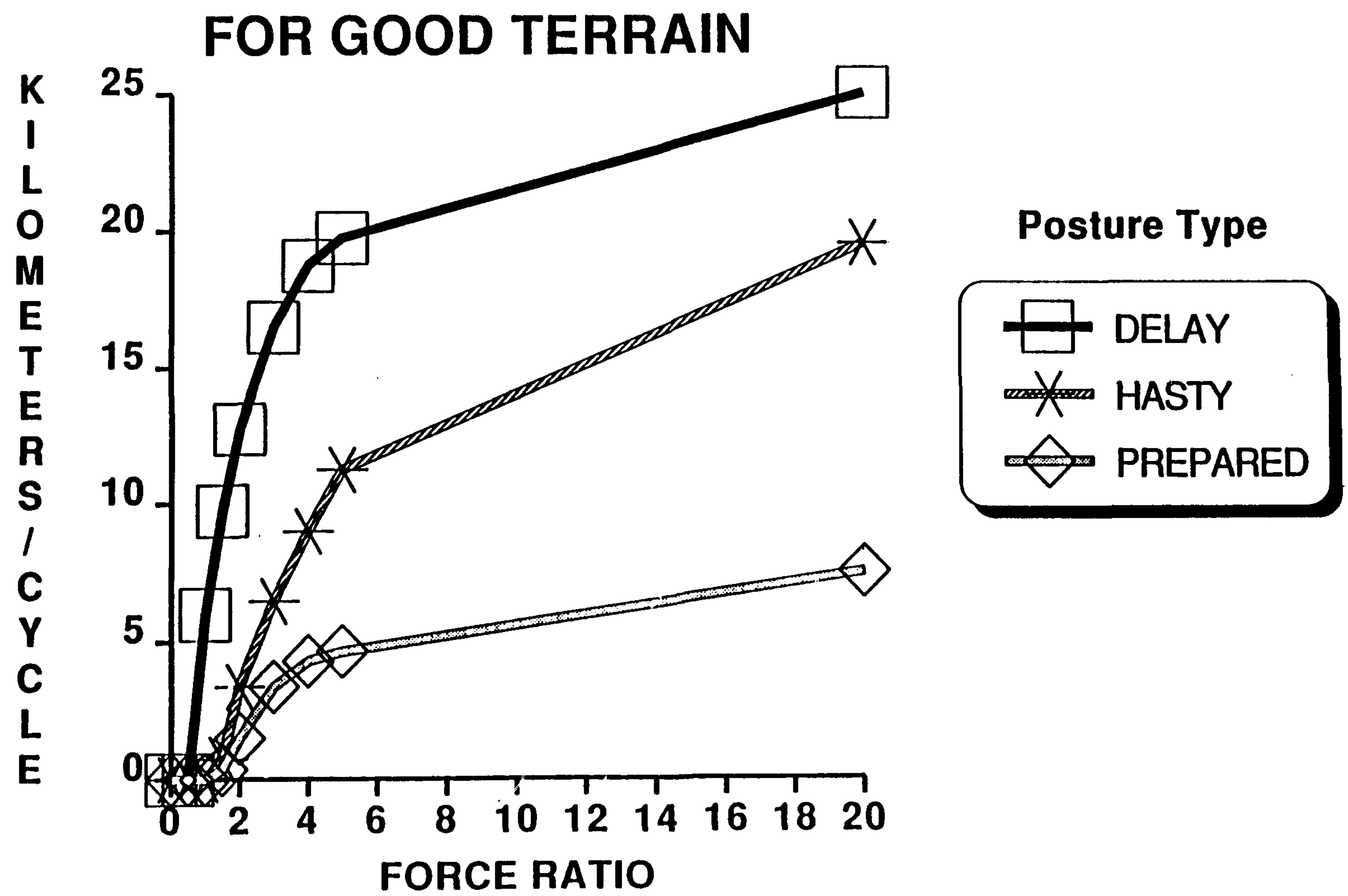
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (6)



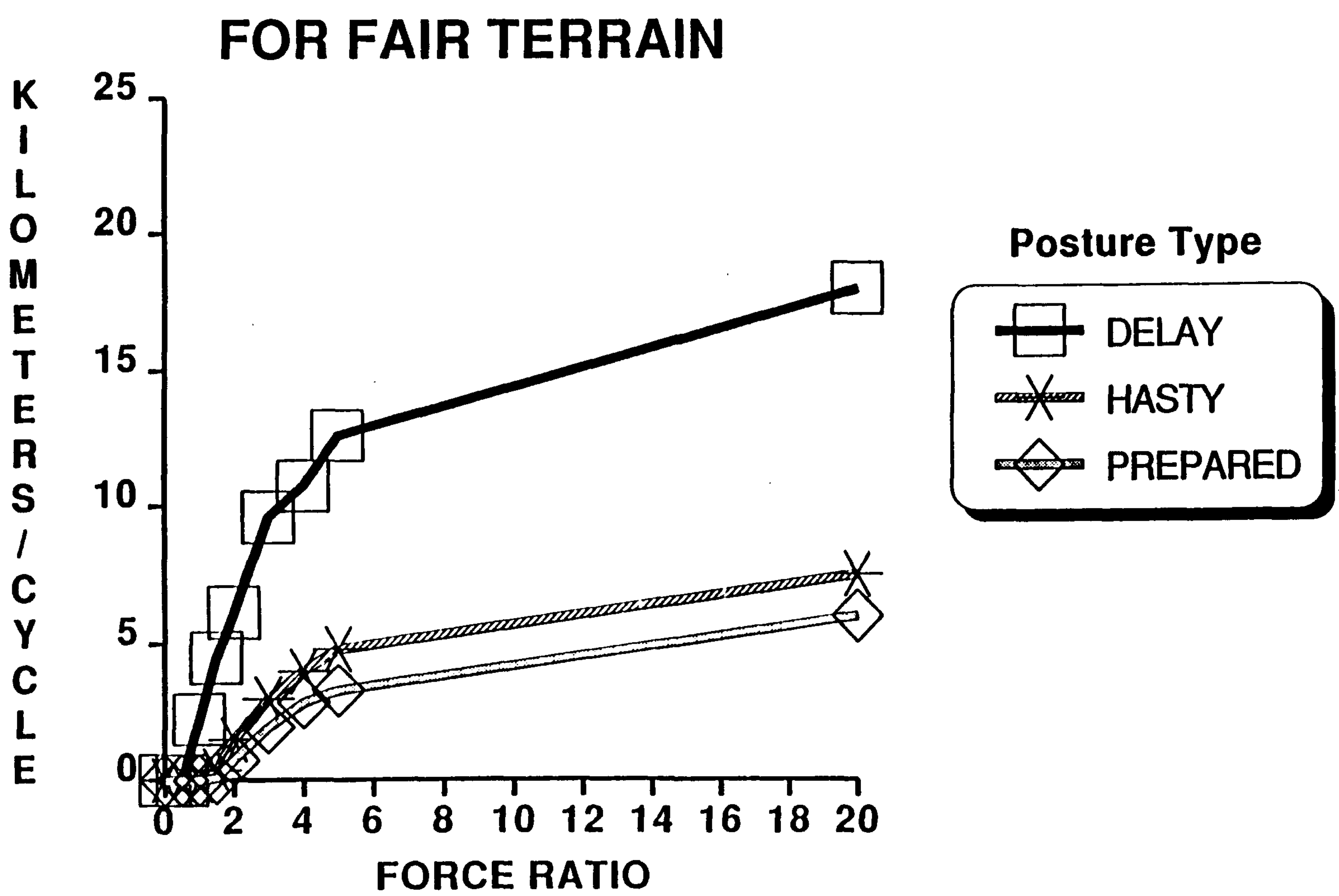
MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (7)

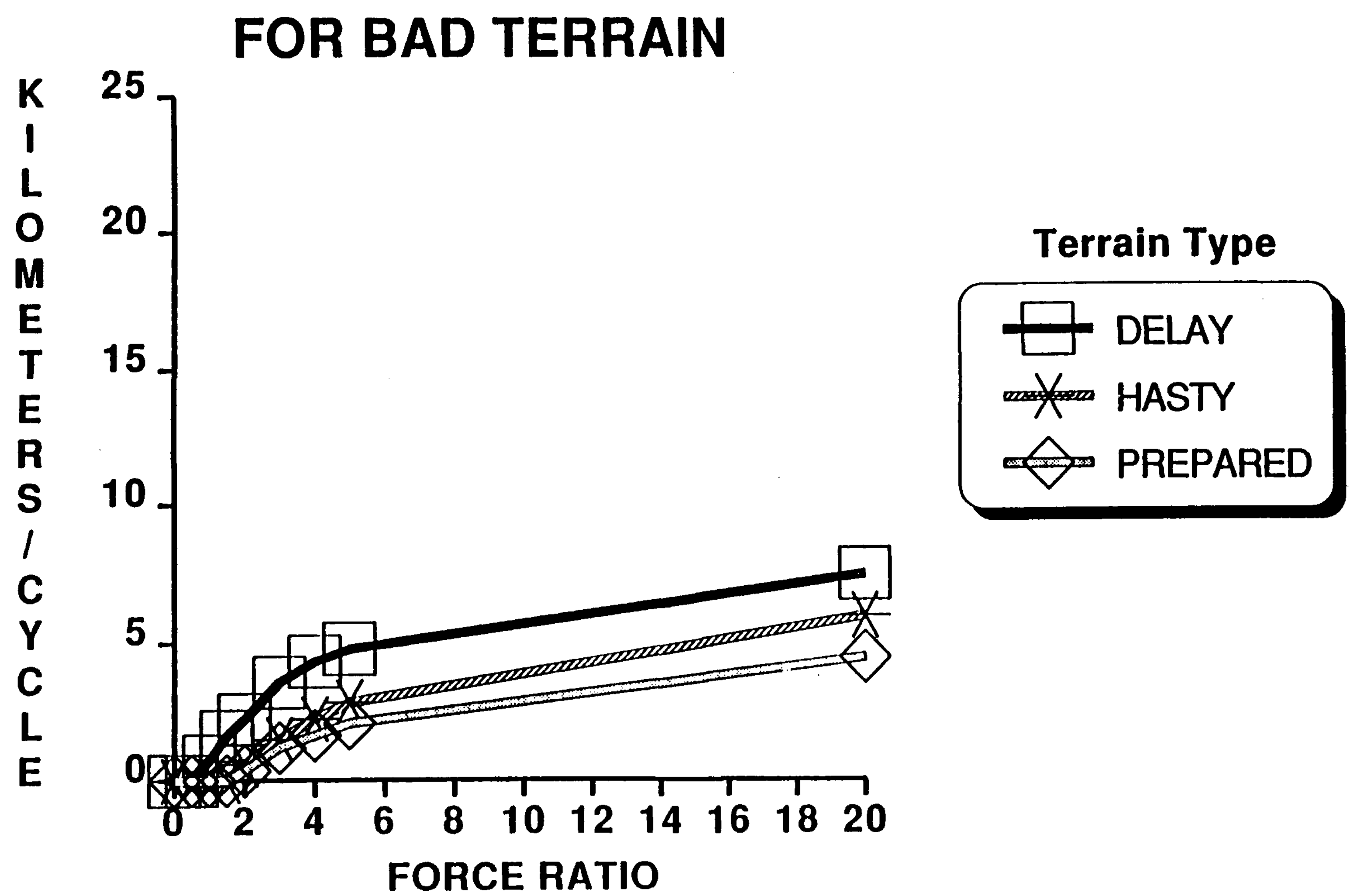


MovementCurves...

MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (8)



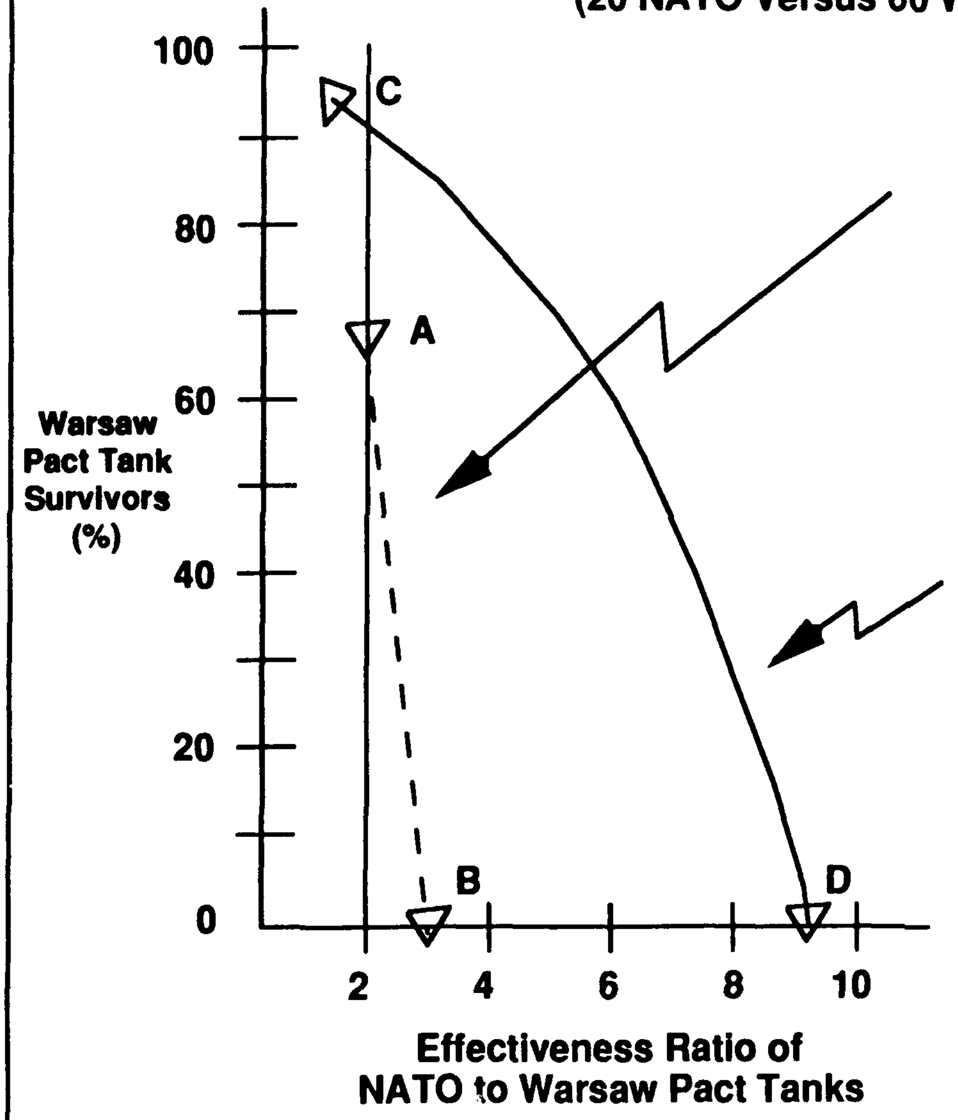
MOVEMENT CURVES USED IN THE IDA TACWAR MODEL (9)



Assorted ground combat modeling related charts from cited sources.

QUANTITY VERSUS QUALITY IN LINEAR AND SQUARE LAW ATTRITION

(20 NATO Versus 60 Warsaw Pact Tanks)



<u>Linear Law</u>:

A. When NATO and Warsaw Pact tanks are equally effective, the NATO force is annihilated with 67% of the Warsaw Pact tanks surviving.

B. When the NATO tank is *three times more effective*, both sides are annihilated at the same time.

<u>Square Law</u>:

C. When NATO and Warsaw Pact tanks are equally effective, the NATO force is annihilated with 95% of the Warsaw Pact tanks surviving.

D. When the NATO tank is *nine times more effective*, both sides are annihilated at the same time.

Source: GAO-PAD-80-21

QuanVsQual

IDA

TABLE I - ARMORED BATTALIONS LAND COMBAT COMMANDS

PROPOSED RATES OF ADVANCE (for use in map maneuvers)

	DEGREE OF ENEMY RESISTANCE (AND ROUGH FORCE RATIOS)				
TYPE OF TERRAIN	NONE	LIGHT AND SCATTERED (6-2 OR MORE)	MODERATE (4-1)	HEAVY (3-1)	VERY HEAVY (2-1 OR LESS)
Open	7-10 (mph)	25-30 (mpd)	15-20 (mpd)	6-12 (mpd)	500-700 (yds/hr)
Moderately Open	5-7 (mph)	20-25 (mpd)	6-15 (mpd)	4-8 (mpd)	300-500 (yds/hr)
Moderately Close	3-4 (mph)	15-20 (mpd)	5-12 (mpd)	200-500 (yds/hr)	100-200 (yds/hr)
Close	1-2 (mph)	7-10 (mpd)	200-300 (yds/hr)	100-200 (yds/hr)	0-100 (yds/hr)
Mountainous	0-1 (mph)	3-6 (mpd)	--	--	--

Source: GAO-PAD-80-21

IDA

TABLE 2 - RATES OF ADVANCE OF INFANTRY BATTALIONS

(IN YARDS PER HOUR)

TYPE OF TERRAIN	AMOUNT OF ENEMY RESISTANCE (AND APPROXIMATE FORCE RATIOS)				
	NONE	LIGHT (FR 5-1 OR MORE)	MODERATE (FR 4-1)	HEAVY (FR 3-1)	VERY HEAVY (FR 2-1 OR LESS)
Open	1400-2500	800-1200	500-800	400-600	300-500
Moderately Open	1000-2000	600-2000	400-600	300-500	200-400
Moderately Close	900-1500	600-900	200-500	150-350	100-300
Close	800-1200	500-700	200-400	150-250	100-200
Mountainous	500-800	30-500	200-300	150-250	100-200

Source: GAO-PAD-80-21

IDA

TABLE 3- HOURS OF INTENSE COMBAT PER DAY

(DURING WHICH MOVEMENT OCCURS)

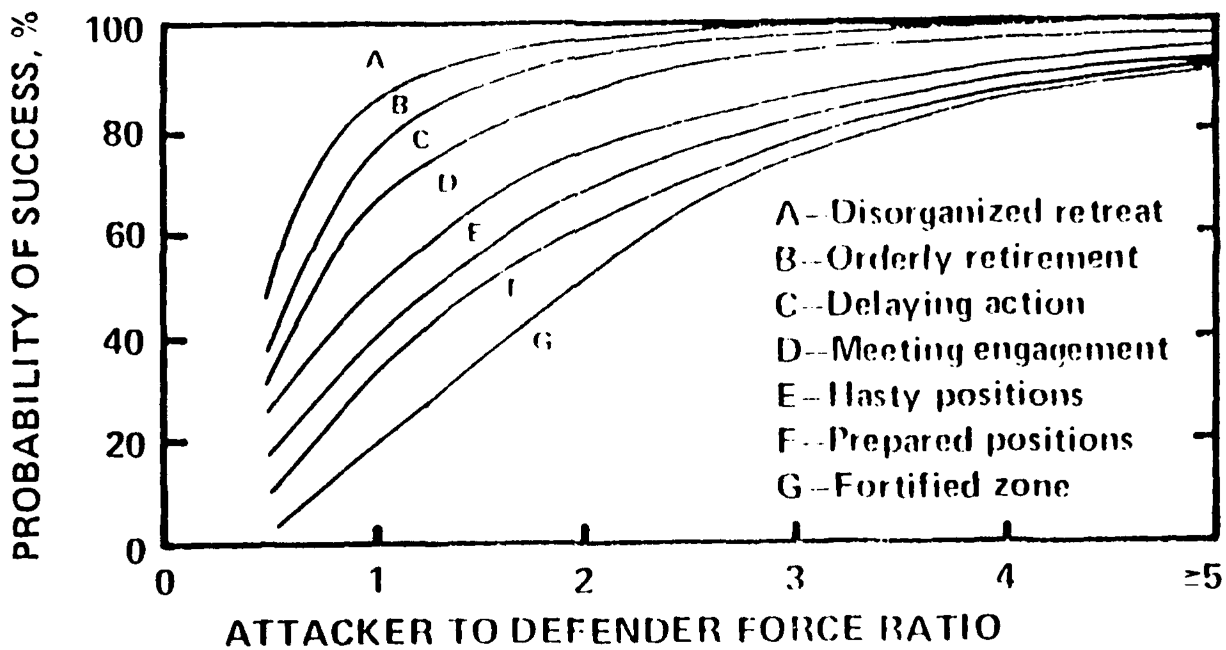
FORCE RATIO	FORTIFIED ZONE [a]	PREPARED POSITION	HASTY POSITION [b]	MEETING [c] ENGAGEMENTS	DEFENDER DELAYING	DEFENDER RETIRING	ROUTE
1.0	0.5	1.6	4.0	5.2	7.9	9.5	10.2
1.5	0.8	2.0	4.8	7.2	9.0	9.6	13.3
2.0	1.4	3.0	5.7	8.0	10.1	11.8	16.0
2.5	2.5	4.4	6.9	8.8	10.9	12.8	18.2
3.0	3.7	5.8	7.7	9.4	11.5	13.8	20.1
3.5	4.8	6.7	8.2	10.0	11.9	14.6	21.3
4.0	5.6	7.2	8.6	10.4	12.1	15.4	22.4
4.5	6.1	7.6	9.2	10.8	12.5	16.0	22.7
5.0	6.6	8.0	9.7	11.4	13.2	16.4	23.0

[a] This column derived from extrapolation from the other postures.
[b] This column derived by graphical interpolation between Prepared Position and Delay.
[c] This column adjusted by graphical interpolation between Prepared Position and Delay.

Source: GAO-PAD-80-21

AnnexD Table3

PROBABILITY OF SUCCESS CURVES



Source: GAO-PAD-80-21

ProbSuccessCurves